

RATIONAL
RECREATIONS,

IN WHICH THE PRINCIPLES OF

N U M B E R S

AND

NATURAL PHILOSOPHY

ARE CLEARLY AND COPIOUSLY ELUCIDATED,

BY A SERIES OF

EASY, ENTERTAINING, INTERESTING
EXPERIMENTS.

AMONG WHICH ARE

ALL THOSE COMMONLY PERFORMED WITH
THE CARDS.

By W. HOOPER, M. D.

V O L. III.

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RATIONAL
RECREATIONS.

VOLUME THE THIRD.

CONTAINING

ELECTRICAL AND MAGNETICAL
EXPERIMENTS.



DESCRIPTION of the PLATES.

PLATE I. p. 16.

THE electric machine. The two boards *a*, *a*, are equal and parallel: the uppermost has a groove, in which one of the pillars is moveable; the other *b*, is fixed. The brass arm *c*, supports the axis *d* that is fixed in the globe; *f* is the rubber, supported by an axis in the wooden circle *g*; *h* is a steel spring, regulated by a screw *i*; *k* is the prime conductor, consisting of a hollow vessel of polished copper, and receives its electricity by means of pointed wires *m*, and the arched brass rod *l*. The globe is turned by the wheel fixed in the moveable frame *e*. The chain *n* connects the rubber with the floor, when positive electricity is required.

PLATE II. p. 26.

The square figure *b*, represents a plated coat of glass. *c*, *d*, *e*, *f*, *g*, *h*, *i*, *j*, *k*, are several sorts of jars. On the stand *c*, are placed on a glass the cork-balls, that serve as an electrometer.

ter. From the end of the conductor at *l*, hang the bells and knobs of brass, for the magic dance; *s* is a metal rod for taking sparks from the conductor.

PLATE III. p. 90.

Fig. 1. The electrometer. *A* is a light rod that turns on the centre of the semicircle *B*, and has at its extremity a cork-ball *C*; *D* is the pillar that supports the rod.

Fig. 2. The fulmineous conductor: *a* is an oblong pole, *b* a copper vessel in form of a funnel, *c* a slender rod, terminated with a pointed wire; *d* is a wire that descends at a foot distance from the building, and is carried into the room where the experiments are to be performed.

Fig. 3. The electric branch and table: *a*, *b*, *c*, *d*, is the table, placed against the partition *X*. The branch *ABC* is joined at *A* to the prime conductor in the other room; *e* and *f* are two links that come from two chains which communicate with the two sides of a jar or battery, and are concealed in the table.

Fig. 4. The apparatus for conducting electricity from a kite: *a* is the string of the kite, wound upon the reel *b*; *c* is a copper funnel, from which goes the metal rod *d*, that has a knob; *e* is the staff that supports the funnel and reel; *f* is

f is the chain by which the electricity is conducted to the ground; *g b i k* the instrument for taking sparks from the apparatus.

PLATE IV. p. 104.

Fig. 1. Represents the row of tin-foil for exhibiting the luminous characters.

Fig. 2. The electrical battery, consisting of sixty-four glass jars, which are connected by brass rods, that run through wires in each of them, and the rods are connected by a chain laid over them.

PLATE V. p. 126.

The method of making artificial magnets. Fig. 1. the poker rubbed by the tongs. Fig. 2, 3, and 4, the manner of giving the bars the vertical touch. Fig. 5, the method of giving them the horizontal touch. Fig. 6, the manner of disposing the bars in a case.

PLATE VI. p. 132.

Fig. 1. AB and CD are the poles of two magnets, and the dotted lines show the direction of the magnetic effluvia.

Fig. 2, and 3. The magnetic perspective. In Fig. 3, B is a magnetic needle, placed on an ivory circle C, that rests on the object glass D: A is

A 4

the

the eye glafs, by which the pofition of the needle is more clearly diftinguifhed.

Fig. 4. The magnetic wand. C is a magnetic bar, which is inclofed in the hollow wand AB.

P L A T E VII. p. 144.

Fig. 1. The bouquets, one of which is to be placed in the vafe E, at the bottom of the box ABCD.

Fig. 2. The magnetic dial. A is a circular border that turns quite free on the ftand B; C a dial of pafteboard, that moves in the circular border; I a magnetic needle, which is the index to the dial; P a pin, that fhews where the magnetic bar Fig. 3, is placed, under the dial.

Fig. 4. The dial for the magnetic cards, which is to be placed in the circular border of the laft figure.

P L A T E VIII. p. 148.

Fig. 1. M and N the two boxes for the dexterous painter; T is a pivot, on which the circle of pafteboard, Fig. 2, is placed, in the box N; O, P, Q, R, are four boards, on which the fame fubjects are painted as on the pafteboard circle; V is an artificial magnet concealed in each of the boards.

PLATE IX. p. 154.

Fig. 1. The apparatus for the cylindric oracle. ABCD is the cylinder, in which is concealed the magnet H, at EF; G is a circle to be placed on the cylinder, and has a touched needle for an index.

Fig. 2. The box in which one of the four square pieces Fig. 3, that have each a magnet in a different direction, is to be placed.

Fig. 4. The dial to be placed over the box, Fig. 2.

PLATE X. p. 162.

Fig. 1. An ewer A, placed on a stand BC, in which is a drawer D.

Fig. 2. The inside of the ewer, in the middle of which is an inverted tin cone; at H is a mirror.

Fig. 3. A pasteboard circle that is placed at QR in the last figure. This circle contains a touched needle, and is divided into four parts, in three of which are heads with different dresses.

Fig. 4. Four square pieces of wood, each of which contains a magnet in different position, and in three of them are the same figures as on the pasteboard.

Fig. 5. The magician's circles. The circle A has a hand that communicates with a movement in

in the box. The index of the circle B is a touched needle: C the cross-piece by which the needles are connected.

Fig. 6. The movement contained in the boxes under the two circles and the cross-piece between them, in the last figure.

P L A T E XI. p. 170.

Fig. 1. The box and dice. CA a hollow pedestal, on which is the circle B, marked with the numbers on two dice, and at its centre is a pivot, on which turns a touched needle; M a similar circle on the bottom of the box; DE is a vase, in which there are different divisions H, G, F. In the part IK is placed the piece ST.

Fig. 2. is a box in which are placed the two cases Fig. 3 and 4, that have each a magnet at O, and in each of which are placed two flowers; GEO is the section of these two cases.

P L A T E XII. p. 178.

Fig. 1. ABCD a box that contains six different pieces of metal, which have each a magnet in a different position.

Fig. 2. The circles that are placed at the end of a perspective, and have the initials of the different metals.

Fig. 3. The box for the magnetic oracle. A, B, C, the three divisions of the box: in A and C are small rundlets marked with numbers.

Fig.

Fig. 4. The magnets to be fixed in eight small tablets that are to be put in the part B of the last figure.

Fig. 5. A circle with a touched needle for an index, which is to be placed on the part B of Fig. 3. over one of the tablets, in which a magnet is concealed.

Fig. 6. ABCD is the box for the magical cards, in the top of which is an opening of the size of a card. At the centre of this box is a pivot, on which is placed a circle that has two cards painted on it, and a touched needle at its center. Between the two figures of the box is the magnetic wand.

P L A T E XIII. p. 184.

Fig. 1. The magnetic planetarium. The central circle A has an index that communicates with another circle underneath; and round it are wrote seven questions. Round the seven lesser circles are wrote words that form answers to those questions; and within these circles are drawn the characters of the five planets, with the earth and moon. On the center of each of these circles turns a magnetic needle, and the dotted lines in each of them show the position of the magnets in seven other circles on the bottom of the box.

Fig. 2. Shows the inside of the box, and the two indexes at top; by the lowest is turned the circle,

cle, fixed on a pivot at the bottom of the box, and the other is placed against one of the months inscribed round the circle. Q and R are two of the needles to be placed on the small circles.

PLATE XIV. p. 190.

Fig. 1 and 2. The magnetical table. ABCD, Fig. 1, the bottom of the table: at A, on the top of the table, is a circle, that surrounds a basin, placed over P, where is the machinery, Fig. 3, which consists of a wheel QR, a barrel X, a small toothed wheel T, and the magnetic bar X Y. MO is a magnetic bar, moveable on a pulley, round which goes a string, that is fastened at one end to the spring N, and goes over another pulley at A. OP, at the part of the table next A B, is a magnetic bar, moveable on a pivot at P. The motion of this bar is regulated by the spring R. Round the pulley T goes a string, that passes over another pulley at S. AB, near the part AR, is the magnetic roller, which is drawn backward and forward by a string that passes over the pulleys B and A, and is described in Pl. XVII Fig. 5.

Fig. 2. A B, the top of the table, on which is placed the basin R, F, G, H, the legs, which are hollow, L, L, the cross pieces, MN the step: these are likewise all hollow, and communicate with the other side of the partition W.

Fig. 4 and 5, are two other circles to be placed round the basin on the table.

PLATE XV. p. 192.

The scale to be placed against the back of the partition W. in Plate XIV. Fig. 2. C is the pulley over which the string goes; D the weight; and EF the index. The divisions of this scale correspond to those on the three circles in the last plate, Fig. 1, 4 and 5.

PLATE XVI. p. 204.

The apparatus for the sagacious swan. Fig. 1. YX a hollow pedestal, on which is placed the basson A, and round it are six vases; B is a hollow egg, placed on a stand C, that is also hollow; MO is the magnet and wheel placed in the pedestal. The figures *a* show the position of the vases.

Fig. 2. The machinery for moving the magnet, which is regulated by one of the etwees Y, and the cylinder F, Fig. 3, placed in the egg B and the stand C.

PLATE XVII. p. 220.

Fig. 1. The communicative bell. AB a copper box, E the inside of the box, F the bell, D a magnet, that is placed on a pivot, and strikes the bell.

Fig. 2. The magnetic balance, the scales of which are to be placed over the magnetic table at the part where is the magnet MO.

Fig.

Fig. 3. The movement of the sympathetic dials. ABCD the wheels and pinions, under which is the barrel A, F the fly, H the plate to which the movement is fixed, LNM a catch of steel that is touched.

Fig. 4. QR is a case in which each of the dials is to be placed.

Fig. 5. The magnetic roller, in the twelve circles of which are placed magnets in different positions, marked with the letters of the alphabet.

PLATE XVIII. p. 232.

Fig. 1. The magician's box. AB is the base of the box, in the top of which is a hole E, about the size of a card: in this base is placed the circle OP, Fig. 3, that has five cards painted on it; contains a magnet QR, and is moveable on a pivot.

Fig. 2, is the body of the box, which consists of four inclined planes of glass; and in a hole at the top is fixed a convex lens V. This box is placed on the magnetic table, by which either of the cards on the circle are brought under the hole.

Fig. 4. The mystical dial: this dial is divided into ten equal parts, and at its centre is a touched needle, which is regulated by the magnetic table.

Fig. 5. The box for the intelligent fly. At the centre of the box is a pivot, on which is placed

placed a touched needle L, that has at one end of it an enamelled fly: over this needle is placed the pasteboard circle ABCD, on which ten letters are wrote.

P L A T E XIX. p. 238.

Fig. 1. The box with the eight tablets, on which are wrote the multifarious verse, and in each of which is concealed a magnet, in a different direction.

Fig. 2. A board of the same size of the foregoing box, on which are drawn eight circles that have each the same words wrote round them as are on the tablets; and on the center of each of these circles is fixed a magnetic needle; this board is to be placed over the box.

Fig. 3. Four plates of glass, placed in an inclined position over the board, and in its top are two lenses O, O.

P L A T E XX. p 246.

Fig. 1. The communicative mirror. AB is a hollow pedestal, in which is a hole at L, and over that is placed a stand, composed of four plates of glass CD, and on that is fixed a tube E, including another tube F. There is a hole through the tubes, next the top of the stand, and against it is placed an inclined mirror M, by which the
eye

eye at G sees the pasteboard circle Fig. 2, fixed on a pivot at the bottom of the box.

Fig. 3. A box of the same size as the pedestal just described. In this box is placed one of the three tablets X, Y, Z, that have each a magnet in a different position, and over each of them is pasted a card of the same sort with those on the circle. When this box is placed in the pedestal the needle in the circle conforms to the position of the magnet in the tablet.

Fig. 4. The box of dice by reflection. ABCD the box, whose top and sides are of glass. I L two hollow cubes. At the end of the box are sliders that draw up as in Fig. 5, and at M is a small moveable piece that covers a hole. OP, and RQ, are two inclined mirrors placed in the box. The bottom of each of the cubes is divided into four equal parts, as in Fig. 8, and under each of them is placed a brass stand, Fig. 6, disposed as in Fig. 7, and on the stand is a pivot that holds two needles, one of brass the other of steel that is touched.

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RATIONAL

RATIONAL RECREATIONS.

ELECTRICITY.

DEFINITIONS.

1. **E**LECTRICITY is that property in bodies which enables them, when excited by friction or heat, to attract other light bodies, and produce an effluvium that is sometimes luminous, attended with a snapping noise, and a faint phosphoreal smell.

2. Electricity is called the second of the three species of attraction, gravity being the first, and magnetism the third.

3. Those bodies that produce electricity by friction or heat, are called electrics, and are said to be electric *per se*.

4. Those bodies that receive and com-

municate electricity are called conductors, and those that repel or will not suffer it to pass through them, are called non-conductors.

5. All bodies that are made to contain more than their natural quantity of electricity are said to be electrified positively, and those from whom part of their natural quantity is taken away, are said to be electrified negatively. These two electricities being first produced, one of them from glass, and the other from amber, wax or rosin, the former was called vitreous and the latter resinous electricity.

6. When a quantity of electricity is communicated to any body, it is said to be charged.

7. The effect of the explosion of a charged body, that is the discharge of its electricity through any other body, is called the electric shock.

8. When any body is prevented from communicating with the earth, by the interposition of an electric body, it is said to be insulated.

9. The

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3

9. The residuum of a charged body, as a jar or battery, is that part of the charge which remains in the body after the first discharge, and by which it will give a second shock, though less than the first.

APHORISMS.

1. All substances are distinguished into electrics *per se*, and non-electrics: the latter of which are conductors, and the former non-conductors.

2. All kinds of metals semi-metals, water, charcoal, and other bodies of a similar nature, are conductors; and all other bodies whether mineral, vegetable, or animal, are non-conductors: many of the latter, however, may be made to conduct electricity by being heated to a certain degree.

3. Positive electricity is produced by the friction of uninfused glass tubes or globes; and negative electricity is produced, either from the rubber of those

B 2

bodies,

bodies, or from the friction of insulated glass bodies; or lastly, from the rubbing of globes or sticks of wax, sulphur, and other bodies of a similar nature.

4. It follows from the last aphorism that the electricity of the excited body and the rubber, are always opposite, that is, if that of the excited body be positive, that of the rubber will be negative; and the contrary. Those two bodies moreover will act on each other with greater force than any other body.

5. In charging any body, as a coated phial, if one side communicate with the excited body, and the other with the rubber, the electricity of the two sides of the charged body will be opposite.

6. There is a strong attraction between the two electricities on the opposite sides of a glass, so that when they are made to communicate by means of a conductor, they will be both discharged with a flash of light and snapping noise.

7. The substance of glass is impervious
to

to electricity; but if the glass be thin, and the electricity on the opposite sides be very strong, that is, if the glass be overcharged, the opposite electricities will force a passage through the glass,

8. If an excited electric be in contact with an insulated conductor, the former will communicate its power to the latter, which will then attract light bodies, and give a spark, in the same manner as the excited electric.

9. The flash of light from a body to which electricity has been communicated, is more dense, and the sound louder than from one that is excited; for the conductor parts with all its electricity at once, but the excited body with only so much as is at, or near, the part that is touched.

10. If insulated bodies have been attracted by, and have touched an excited body, they will, soon after, be repelled by that body, and will repel each other; nor will they return to the excited electric

till after they have touched some other body that communicates with the earth.

11. When an insulated conductor is brought within the sphere of action of an excited body, it acquires, the electricity opposite to that of the body, and the nearer it is brought, the greater quantity it acquires, till the one receive a spark from the other, and then the electricity of both is discharged.

12. The electric explosion always takes the shortest course through the best conductors.

13. If the explosion between two bodies be interrupted by a non-conductor of a moderate density, the discharge will force a passage through it, in such manner as to leave the appearance of a sudden expansion of the air about the center of the explosion.

14. If an insulated conductor be pointed, or if an uninsulated conductor that is pointed, be brought very near the earth, there will be no other appearance of electricity

tricity during the time of excitation than a light, and a current of air, that may be perceived to come from those points.

15. The electric attraction acts in vacuo.

16. Electricity and lightning are in all respects of a similar nature.

17. All the effects of lightning may be imitated by electricity, and all the experiments in electricity may be performed by lightning, brought down from the clouds by means of an insulated pointed rod of metal, as described at page 35, &c. of this volume; or by a kite described at page 82, &c.

ELECTRICAL APPARATUS.

A Description of all the machinery that has been used in electrical experiments, would fill a large volume. We shall here confine ourselves to such as are of general use, and necessary, in particular, to the following recreations: such are the revolving globe and rubber, with its prime conductor, usually called an electric machine; the electric battery; the fulminous conductor; and the electrometer.

The construction of the electric machine is as follows *. Let *a a*, Plate I. be two

* A great number of different electrical machines have been contrived. This appears to be the invention of Dr. Priestley, from whose History of Electricity we have extracted the description of the following apparatus, and the subsequent Recreations, some few articles excepted; for that valuable work contains every material discovery or improvement that has been hitherto made in this science. A machine of a more simple construction will be described farther on.

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strong boards of mahogany, the lower about an inch on each side broader than the other: they are to be an equal length, parallel with each other, and about four inches asunder. In the upper board is a groove that goes almost its whole length. The pillars are of baked wood: that marked *b* is immoveable, being fixed to the upper and lower boards; the other slides in the groove just mentioned that it may receive globes or cylinders of different dimensions*, but is only necessary when they have axes. In each of the pillars there are holes at equal distances, by means of which the globes may be placed at a height adapted to their bulk. These pil-

* It is not yet determined what sort of glass is most proper for these globes and cylinders. The best flint is commonly used, but Dr. Priestley seems to think, that common bottle-metal is the most eligible. Some operators line their globes or cylinders with wax, or some other electric substance: which in large globes may be of good use; but when they are small, no material advantage can be expected from any lining.

lars

lars are to be high enough to admit two or more globes at the same time. If two globes be fixed on one axis, four of a moderate size may be used, and the wheel may have several grooves for that purpose. When a globe with one neck is used, as in the plate, a brass arm *c*, with an open socket, is necessary to support the axis beyond the pulley: this part is also contrived to put higher or lower, together with the brass socket in which the axis turns. The axis *d*, is made to come quite through the pillar, that it may be turned by a handle, without the wheel, at the option of the operator. As the frame screws to the table, it may be placed at different distances from the wheel, in proportion to the length of the string, in different states of the air. The wheel is fixed in a separate frame *e*, by which means it may be placed in any situation, with respect to the pulley, and be turned to one side, so as to prevent the parts of the string from cutting each other. The back
part

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part of this frame is supported by a separate foot*.

The rubber *f*, consists of a hollow piece of copper, stuffed with horse hair, and covered with a basil skin. It is supported by a socket, that receives the cylindrical axis of a round flat piece of baked wood *g*, the opposite part of which is inserted into the socket of a bent steel spring *h*†. These parts are easily separated; so that the rubber, on the piece of wood by which it is insulated, may be

* Some electric machines are turned by a brass toothed wheel and pinion, inclosed in a box, which has a more elegant appearance: but these wheels are subject to accidents, which are not so easily repaired as those that happen to a string.

† If the rubber be very narrow, some parts of the globe will pass without a sufficient friction: to remedy this inconvenience, an apron of oiled silk, such as is used for umbrellas may be fastened to the rubber, to supply the deficiency. There should be no sharp edges or angles about the rubber, for they would make its insulation, which is a matter of great consequence, ineffectual.

changed

changed at pleasure. The position of the spring may be altered two ways: it may either be flipped along the groove, or moved in the contrary direction, so as to give it every desirable position with regard to the globe or cylinder: and it is, besides, furnished with a screw *i*, which makes it press harder or lighter, as the experiment may acquire.

The prime conductor *k**, is a hollow vessel of polished copper, in the form of a

* For common purposes a small conductor is most convenient; but when a strong spark is wanted, it is proper to have a large conductor ready, which may be placed in contact with the smaller. But whatever be the size of the conductor, that part which is most remote from the globe should be round, and much larger than the rest: for the effort of the electric matter to fly off, is always the greatest at the greatest distance from the globe; and from that part the longest and strongest sparks may be drawn.

The largest and most pungent sparks are drawn from any conductor along an electric substance. Thus if the conductor be supported by pillars of
glass

peaf, fupported by a pillar on a firm basis of baked wood*; and it receives its

glafs or baked wood, the longeſt ſparks will be taken cloſe to the pillar.

If part of the conductor be concave, a remarkable large, ſtrong, and undivided ſpark may be drawn from the concavity. Where the ſurface is convex, the ſpark is more apt to be weak and divided.

* Baked wood is found by experience to form a perfect inſulation, but it requires to be baked again at different times, eſpecially if it be kept in a damp ſituation. A pillar of glaſs varniſhed with ſealing wax, will answer exceeding well, and does not require ſo much attention. The beſt method of varniſhing a glaſs is to diſſolve ſo much ſealing-wax, in ſpirit of wine, as will make it of a due conſiſtence. It may then be laid on the glaſs, by a brush, with very little trouble.

Dr. Prieſtley adviſes electricians to make all their ſtands and ſtools for inſulation, of baked wood; as it may be eaſily turned into any form; as it inſulates better than glaſs, and is not ſo brittle. But care muſt be taken that the wood be thoroughly baked, even till it be quite brown: it will not then be very apt to collect moiſture from the air: if it ſhould, a little warming and rubbing will be ſufficient to expel that moiſture. At moſt, it can only be neceſſary to boil it in linſeed oil, or give it
a flight

electricity by means of a long arched wire, or rod of very soft brass *l*, easily bent into any shape, and raised higher or lower as the globe may require: it is terminated by an open ring, in which are hung some sharp-pointed wires or needles *m*, that play lightly on the globe when it is in motion.

The body of the conductor is furnished with holes and sockets, for the insertion of metallic rods, to convey the fire wherever it is wanted; and for many other purposes, incident to a course of electrical experiments. The conductor is by this means steady, and yet may be easily put into any situation. It collects the fire perfectly well, and (what is of the greatest consequence, though but little regarded) retains it equally every where.

a slight coating of varnish after it comes out of the oven. When this preparation is used, it must be well heated once more, immediately after the boiling.

When

When positive electricity is wanted, a wire or chain, as is represented in the plate at *n*, connects the rubber with the table, or floor. When negative electricity is wanted, that wire is connected with another conductor, such as that represented at *t*, Pl. II. while the conductor in Pl. I. is connected, by another wire or chain, with the table. If the rubber be made tolerably free from points, the negative power will be as strong as the positive.

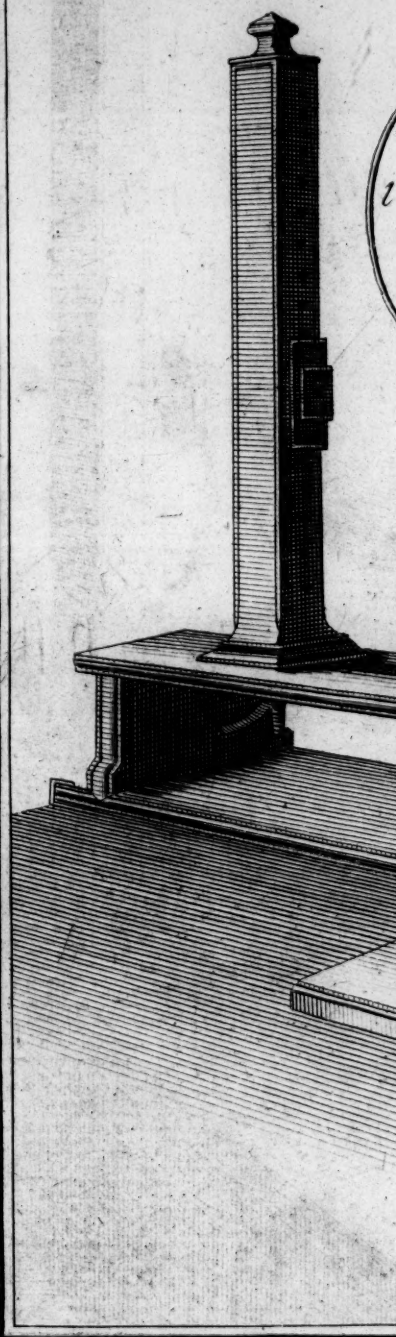
The principal advantages of this machine are, that glass vessels, or any other electric body, of any size or form, may be used, either with one or two necks. All the essential parts of the machine, as the globe, the frame, the wheel, the rubber, and the conductor, are quite separate, and the position of them to each other may be varied in every manner possible. The rubber has a complete insulation, by which means the operator may command either the negative or positive power, and may
 7 change

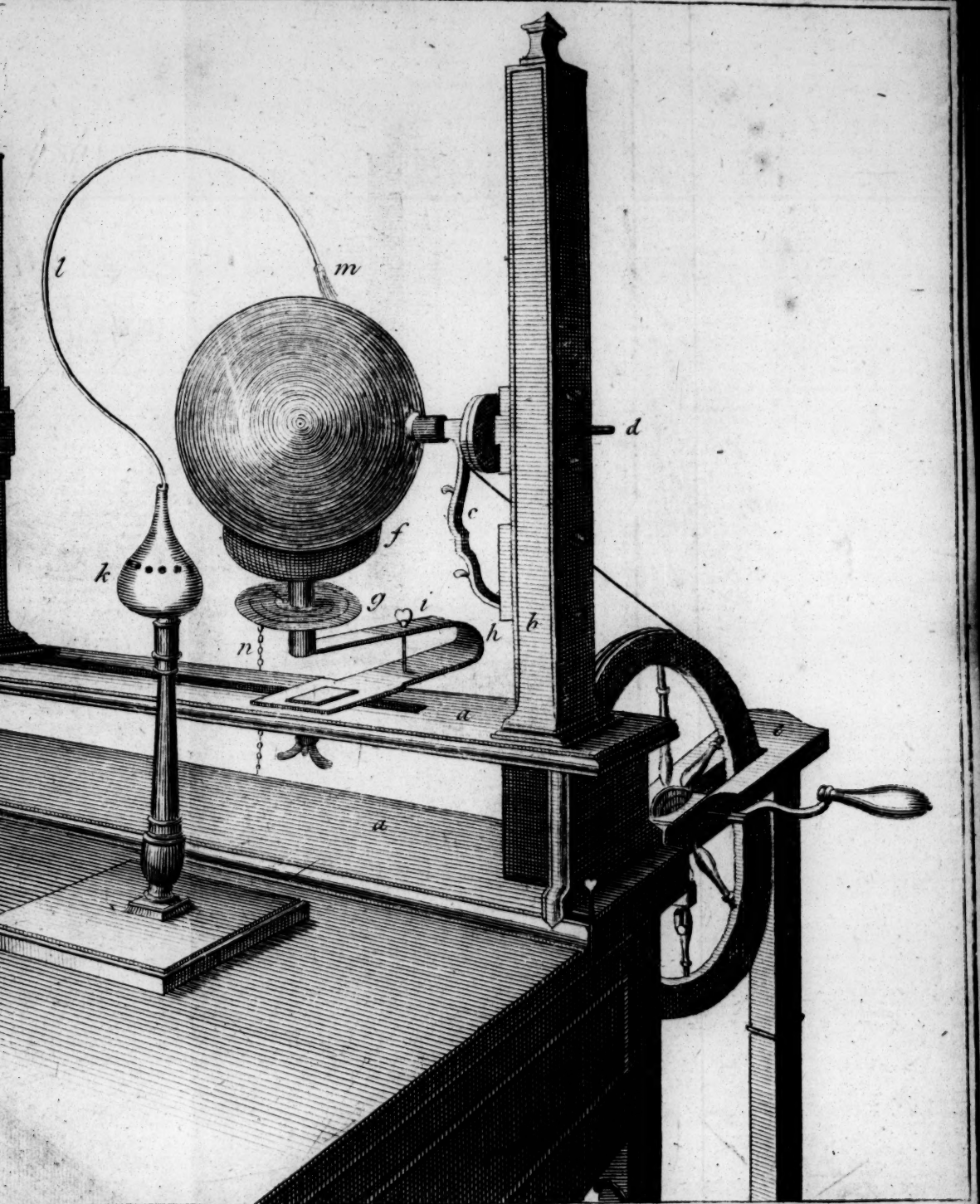
change them in an instant. This conductor is steady, and easily enlarged, by placing rods in the holes with which it is furnished, or by the conjunction of other conductors, in order to give larger sparks, &c. It may be turned either with or without the wheel, so that the operator may sit or stand to his work, at his option; and he may, with the utmost ease, manage the machine and the other parts of the apparatus*.

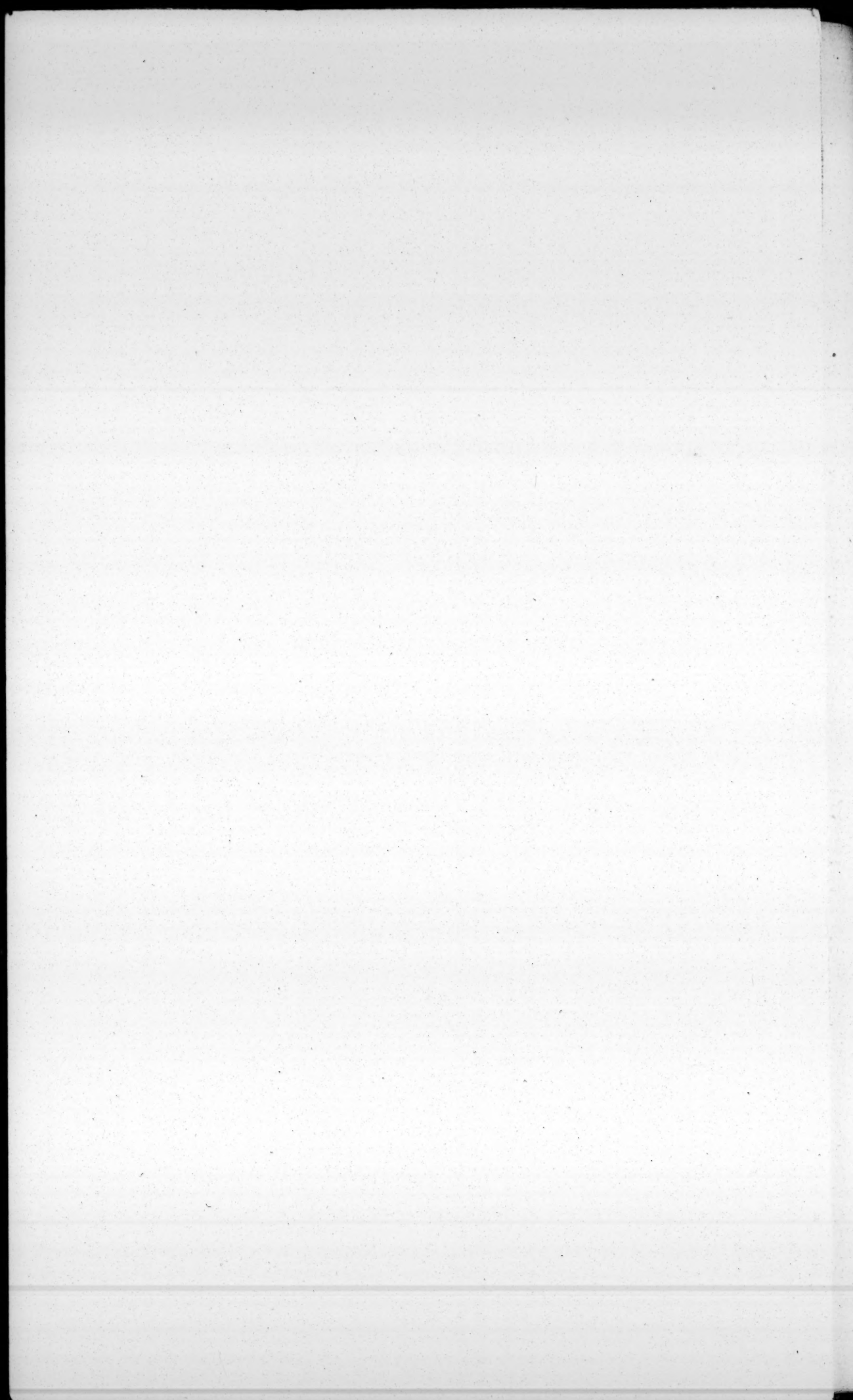
When the air is dry, particularly when there is a frost, and the wind is north or

* We are informed that Dr. Priestley, since the publication of his History, has contrived a windmill, to be placed on the top of his house, by which his electrical machine is occasionally turned. One or more globes, excited by the force of a strong wind, must doubtless produce a very great quantity of electricity; and from that gentleman's extensive knowledge of this science, and his unwearied application to the improvement of experimental philosophy, the learned world has reason to hope for some farther important discoveries in electricity.

east,







east, there is scarce any electric machine but will work very well. If the air be damp, make a large fire in the room where the machine stands, and let the globe, and every thing about it, be made very dry: it will then work almost as well as in the best state of the air.

To increase the quantity of electric fire from a globe, let the rubber be a little moistened, from time to time; or rather, moisten the under side of a loose piece of leather, that may occasionally be put upon the rubber. But the most powerful exciter is a little amalgam, made by rubbing mercury and thin pieces of lead or tin-foil together, in the palm of the hand. If a rubber be at any time placed perpendicular to the horizon, it will be necessary to use a little tallow or pomatum to make it stick. With this excellent resource, almost all sorts of weather become equally fit for electrical experiments.

A little time after fresh amalgam has been put upon the rubber, and often at other times, if there be any foulness upon the cushion, and sometimes when there is none, there will be found upon the globe small black spots, of a hard rough substance, which grow continually larger, till a considerable quantity of that matter be accumulated upon the surface. This must be carefully picked off, or it will obstruct the excitation, and in a great measure defeat the intended operation.

When the amalgam has been used for some time, there will be formed upon the rubber, a thick incrustation of the same kind of black substance that is apt to adhere to the globe. This incrustation is a very great improvement of the rubber; for when once a considerable body of it is formed, and it is a little moistened or scraped, as much fire will be produced as if fresh amalgam were used; so that it seems to supersede the farther use of the amalgam:

As

As the electric matter is collected only at the rubber, it is necessary that it have a communication with the common mass of the earth, by means of good conductors. If, therefore, the table on which the machine stands, or the floor of the room in which it is used, be very dry, little or no fire will be got, be the machine ever so good. In this case it will be necessary to connect the rubber, by means of chains or wires, with the floor, the ground, or even the next water, if the neighbouring ground be dry.

If the conductor be made perfectly well and the air be dry, there will never be any loss of fire from any part of it; for when the whole surface has received as high a charge as the machine can give, it will, in all places alike, perfectly resist all efforts to throw any more upon it, and the circulation of the fluid by the rubber will be stopped, being balanced, as it were, by equal forces. Or if it lose, in all places alike,

alike, the dissipation must be invisible. This maxim almost admits of ocular demonstration; for when the rubber is perfectly insulated, and the conductor has an opportunity of discharging itself, the rubber will take sparks from a wire placed near it very fast; but when the conductor has but little opportunity of discharging itself, it will take fewer of those sparks.

The larger the conductor is, the stronger sparks it will give: for the greater the electric surface, the greater quantity of the electric atmosphere it contains, and the more sensible its effect will be, when it is all discharged at once. The conductor, however, may be made so large, that the necessary dissipation of the electric matter from its surface into the air, will be equal to the supply from the machine, which will constitute the maximum of the power of that machine, and which will be different in different states of the air.

To

To form a just estimate of the electric power of different machines, take two wires with knobs of any size, and fix one of them at the conductor of one of the machines, and the other wire about an inch or an inch and a half from it; and as the wheel turns, count the number of sparks that pass between them in any given time. Fix the same wires to the conductor of another machine (but if the same conductor were used the trial would be more exact) and the difference between the number of sparks in the given time will determine the difference of strength in the two machines *.

* For common purposes there are electric machines constructed without either globe, cylinder, or wheel, as thus: let two upright pieces of wood, of about two feet long, be joined at bottom by a cross piece, and let there be a gripe to fasten them to a table, or any horizontal board. Against the inside of each of the perpendicular pieces fix a leather cushion, and let there be a hole made thro' each piece and cushion, opposite to each other. Then take a plate of glass, about a foot square, and polished on both sides, through the middle of

The electric machine being thus completely adjusted, the operator will next want metal rods to conduct, and coated glass jars or phials to retain and communicate the electric fire. Metallic rods, such as *s*, Plate II. used in taking sparks from the conductor for various purposes, should have knobs, of different dimensions, which let a workman make a hole, of the same size with those in the posts and cushions: if these holes be about nine inches from the top, you may work the machine either sitting or standing. Thro' all the holes let an axis be passed, that has a handle at one end. The cushions are to press hard against the glass.

Next, provide a conductor, which may consist of a small iron rod, fastened by sealing-wax to an upright piece of wood, supported by a glass vessel of any sort; from the rod must go a wire, at the end of which are to be two large needles, that communicate with the two sides of the glass; and from each of the rubbers there must go a chain to the floor or table. When positive electricity is wanted, the needles are to communicate with the glass; and when negative electricity, with the cushions. With this machine and a little care and practice you will be enabled to perform all the common operations in electricity.

in proportion to the curvature of the conductor. If the knob be too small, it will not discharge the conductor at once, but by degrees, and with less sensible effect; whereas the spark between broad surfaces is thick and strong.

This most formidable part of the electric apparatus is the coated glass, used in the Leyden experiment* and the battery. The form of the glass is immaterial with respect to the shock; but for different experiments both plates and jars, of various shapes and sizes, must be used. The most commodious form, for common use, is that of a jar, as wide as a person can conveniently grasp, and as tall as will stand without danger of falling: perhaps about three inches and a half diameter, and about eight inches high. The mouth

* By the Leyden experiment is here meant the shock that is given by two wires, communicating with the two sides of a charged coated glass or phial.

should be pretty open, that it may be the more conveniently coated on the inside, as well as on the outside, with tin-foil: but it will be generally most convenient to have the mouth narrower than the belly, for then it may more easily be kept clean and dry, and the cork, when one is wanted, will be easier to manage. A jar thus prepared, of a moderate size, is called the Leyden phial. But no electrician should be without jars of various forms and sizes. The figures of several of them are expressed in Plate II. at *c*, *d*, *e*, *f*, *g*, *h*, *i*, *j*, and *k*. The form of a plated coat of glass is represented at *b*.

The practice of coating jars is far preferable to that of putting water, or brass shavings, into them, which not only makes them heavy, but incapable of being inverted, which is requisite in many experiments. Brass dust, or leaden shot, are, however, very convenient for small phials, and serve very well where it is necessary to remove
the

the coating as soon as the jar is charged, but in this case quicksilver will generally answer best. The tin-foil may be put on either with paste, gum-water or bees wax. To coat the inside of vessels that have narrow mouths, moisten the inside with gum-water, and then pour some brass dust upon it; enough will stick on to make an exceeding good coating, and will not easily come off, unless something very hard rub against it.

Being thus provided with a machine to produce, and jars to receive, the electric matter, it will be proper, in the next place, to construct an electrometer, that you may know when your jars are sufficiently charged*. There have been

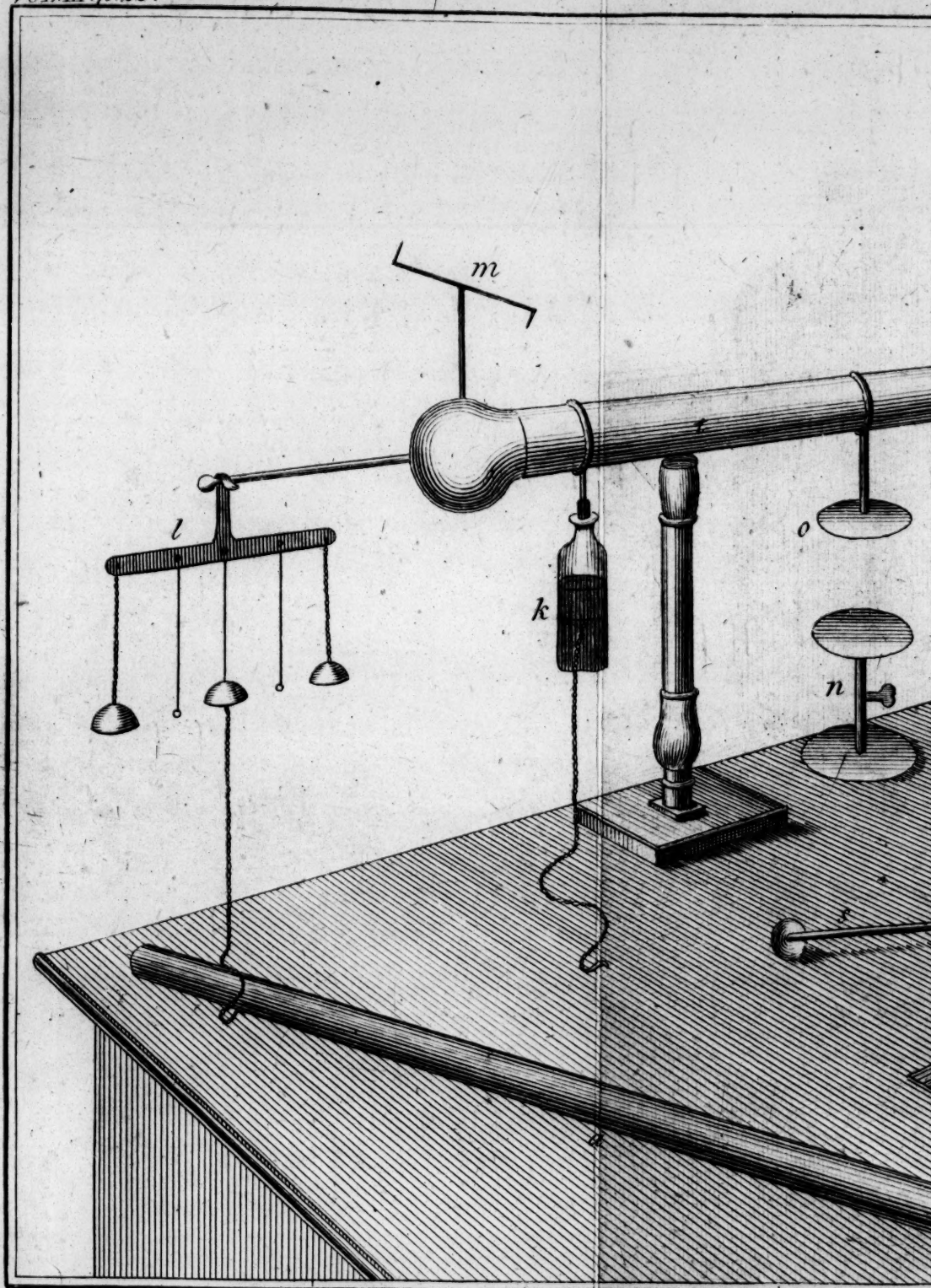
* The most effectual method of charging a jar, is to connect the outside, by means of wires, with the rubber, while the wire, proceeding from the inside, is in contact with the conductor. In this manner the inside of the jar will be supplied with the very same fire that left the outside. In this case also the jar will receive as high a charge as it is capable of receiving, though

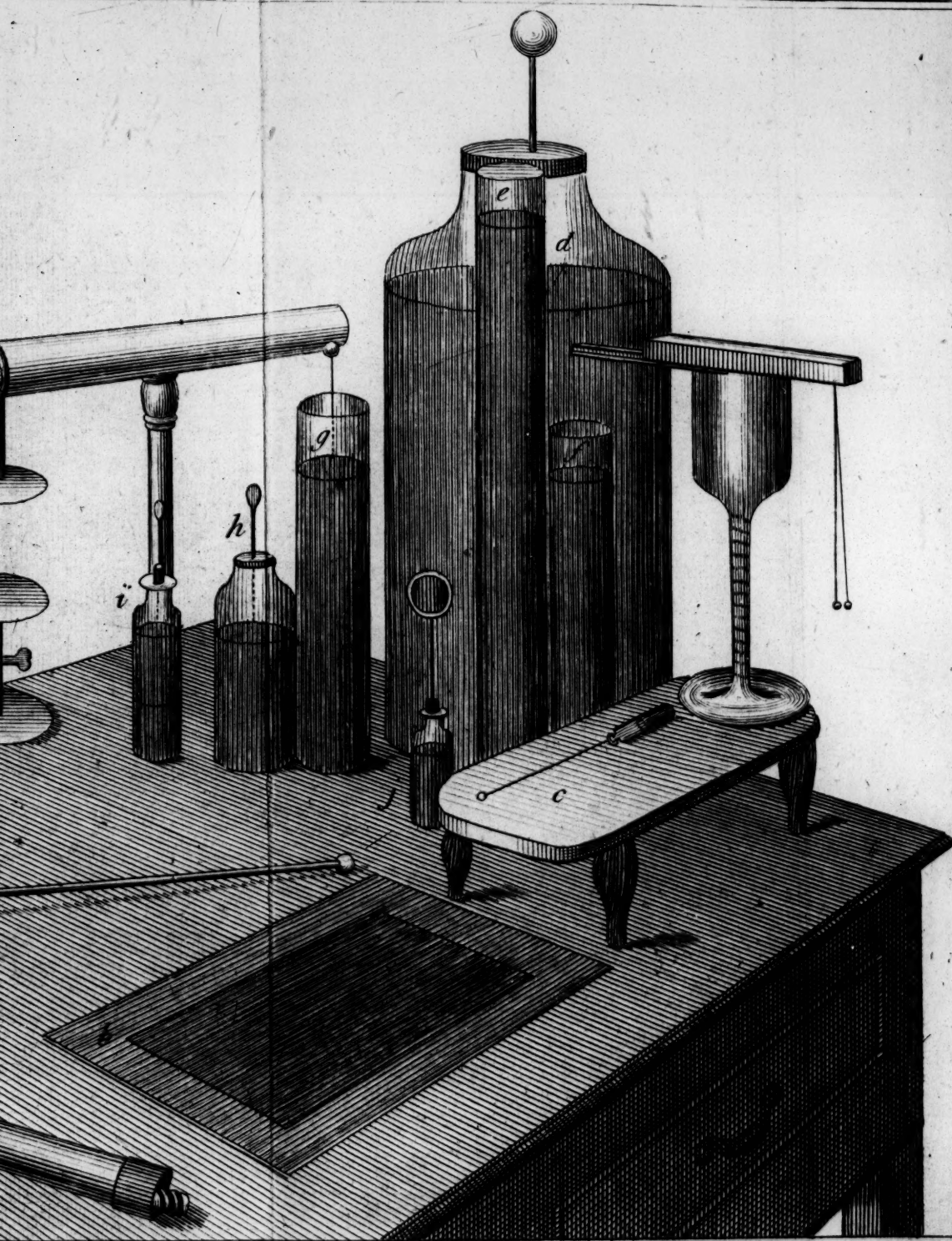
many different inventions for this purpose. That of Mr. Canton is one of the most simple, and is useful on many occasions. It consists of two pieces of cork, or pith of elder, nicely turned in a lathe, to about the size of a small pea, and suspended on fine linen threads, represented at *c*, Plate II. on a glass, standing on a stool. It is convenient to place them in a small box for the pocket; the box should be the full length of the strings, that they may lie in without being bent*. These

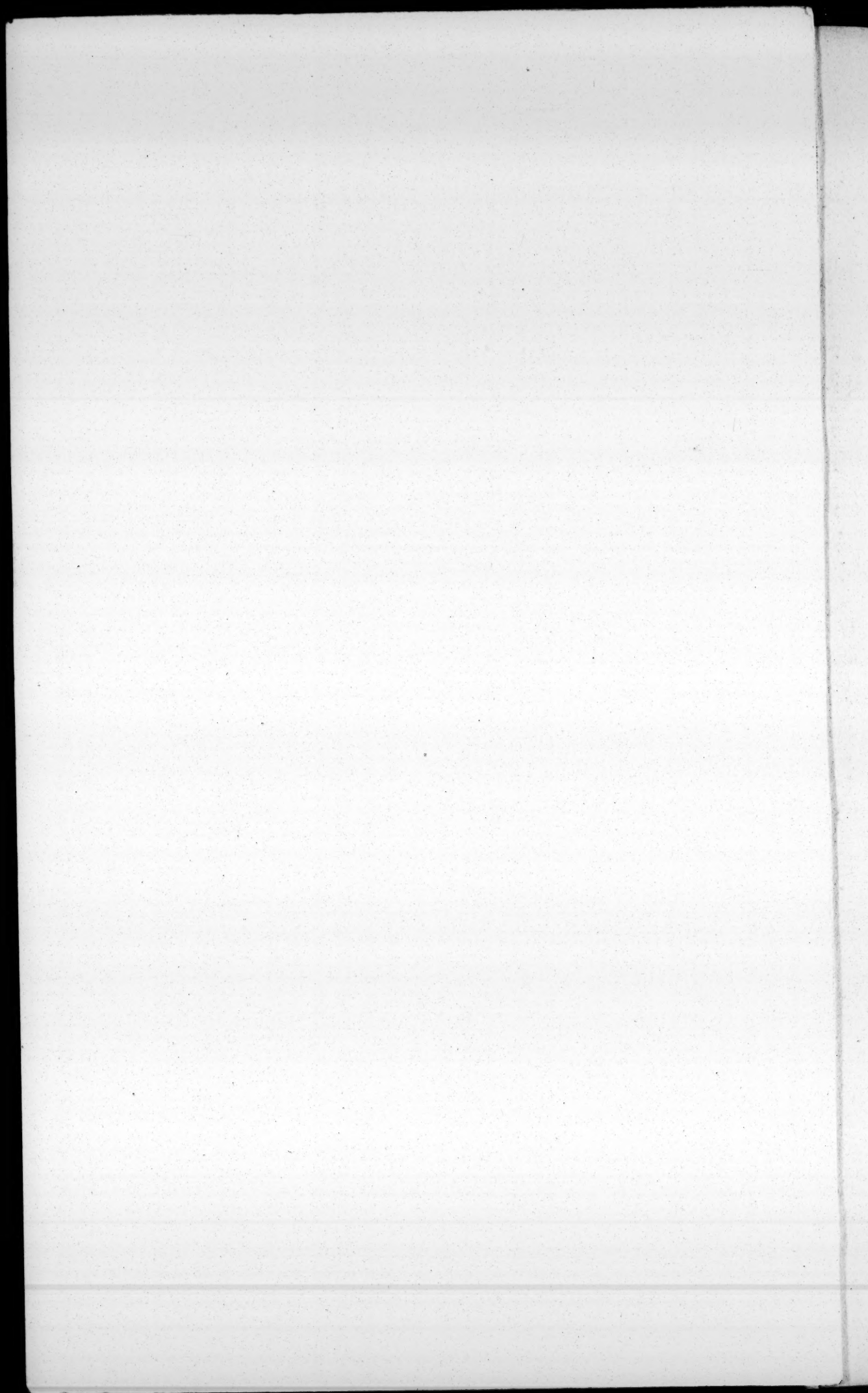
though the rubber be insulated, and have no communication but with the outside coating; so that in the case of charging, there can be no occasion for the directions given above, when the table, the floor, or the ground are very dry. When a thin jar is discharged, it is adviseable not to do it by placing the discharging rod opposite the thinnest part, as it will endanger the bursting of the jar in that part.

* If a smooth cork ball be hung on a long string of silk, and electrified positively, it will always be repelled by positive, and attracted by negative electricity.

balls







balls not only show when a jar has a sufficient charge, but also discover a very small degree of electricity, and mark its changes from positive to negative, and the contrary*.

* If two pith balls, hung by linen threads, and diverging with positive electricity, be insulated; though in connection with conductors of considerable length, the approach of a body electrified positively, will first make them separate, and then (if the electricity of the balls be small, and that of the approaching body great) it will at a certain distance make them approach, and at length come into contact with it. Sometimes the divergence, previous to the convergence is very small, and without great attention, is apt to be overlooked.

If the balls have a free communication with the earth, for instance, if they be held in the hand of a person standing on the ground, and (as in the former case) they be made to diverge with positive electricity, in consequence of being held within the influence of a body electrified negatively, the approach of positive electricity will make them converge; and negative electricity diverge: the electric matter of the approaching body, in the former case, repelling that of the balls, and thereby as it were, un-electrifying them; whereas, in the latter case, the
negative

But the most sensible of all electrometers consists of two or three threads of silk, as they come from the worm, to which is fastened a piece of down, that is just sufficient to keep them perpendicular to the horizon. If insulation be necessary, fasten them to a piece of baked wood. When the ends of these threads have received a small degree of electricity, they will retain it a considerable time, and the slightest electric force will put them in motion*. But before any experiment be made, it will be proper to observe carefully, how long they will retain the degree of electricity that is intended to be given them, in any

negative electricity of an approaching body draws it more powerfully into the threads and makes them diverge more. This method of judging is, therefore, excellently adapted to ascertain the kind of electricity in the atmosphere, or of a charged jar or battery; the balls being held in the hand of a person standing on the earth or floor.

* These threads will discover a smaller degree of electricity that can be easily perceived by the balls.

fitu-

situation, and a proportionable allowance is to be made in the course of the experiments.

The only instrument, however, that can with propriety be called an electrometer, that is such as measures the precise degree to which any body is electrified, was invented by Mr. Henly, and is described in the Philosophical Transactions, in a letter from Dr. Priestley to Dr. Franklin, and is as follows: A (Plate III. Fig. 1.) is a very light rod, that turns on the center of a semicircle B, so as always to keep pretty near its graduated limb: at the extremity of the rod is a cork ball C. D is the pillar that supports the rod, and may be either fixed on the prime conductor, or let into the brass knob of a jar or battery, or be set on a stand to support itself. The whole instrument may be made of wood or ivory, but is found most perfect when the pillar and rod, or index, are of box, made very smooth with emery paper: the ball of
cork,

cork, and the semicircle, ivory, as the divisions on that are more legible than on wood.

The moment this instrument begins to be electrified, the cork ball is repelled by the pillar, and consequently begins to move the rod over the edge of the semicircle, and shows, to the greatest precision, the degree to which the prime conductor is electrified; or how high any jar or battery is charged. As the materials of which this instrument are made, are very imperfect conductors, it will very rarely dissipate any of the electricity of the prime conductor, &c. with which it is connected; but if it be found, by a trial in the dark, that any part of it collects the electric matter, it must be placed before the fire to dry off the damp, particularly from the index: it should not, however, be much heated, for then it will not receive the electricity ready enough, and the motion of the index will not answer with sufficient accuracy, to the degree of electricity in the body with which it is
in

in contact ; but this inconvenience may be easily remedied by moistening the pillar and the index ; for the semicircle can never be dry.

It is evident, from the construction of this instrument, that the force of different explosions may be ascertained by it, before the discharge, with the greatest accuracy. If a jar be charged with positive electricity, and you want to know the precise time, while you are attempting to charge it negatively, that it becomes discharged, watch the moment the index comes to the perpendicular station, which may be observed without the least danger of a mistake, and you will then find there is not the least spark left in the jar. If you continue the operation, the index will begin to advance again ; and thereby show the exact quantity of the opposite electricity the jar has acquired.

The

The electrical battery is composed of a number of coated jars, enclosed in a case, as in Fig. 2. Plate IV. Very large jars are not the most eligible; those that are smaller contain a greater coated surface in proportion to their bulk; and it is by that the force of a battery is produced. The largest jars that can be conveniently made are about 17 inches high, and they should not be more than 3 inches in diameter, and every where of an equal width.

The battery used and recommended by Dr. Priestley, consists of 64 glass jars*, each 10 inches high, and two inches and a half diameter, and coated to within one inch and a half of the top. The coated part of each is, therefore, half a square foot; so that the whole battery contains 32 square feet. The wire of each

* A less number, however, will be quite sufficient for common purposes: on the contrary, where a very great force is wanted, two or more batteries may be connected, and separate jars added to them.

jar has a piece of very small wire twisted about the lower end of it, to touch the inside coating in several places, and it is put through a pretty large piece of cork, within the jar, to prevent any part of it touching the side, which would tend to promote a spontaneous discharge*. Each wire is turned round so as to make a hole at the upper end, and through these holes is put a pretty thick brass rod with knobs; one rod serving for one row of the jars.

The communication between these rods is made by laying over all of them a chain, which is not drawn in the plate, lest the figure should appear confused. When you would use only a part of the battery, you lay the chain over as many rods as you want rows of jars. The bottom of

* Instead of this wire with a cork, the jars of some batteries have wires bent double, whose lower parts are springs, so that they touch the sides of the jar next the bottom, without coming near the top.

the box, on which these jars stand, is covered with tin foil and brass dust; and a bent wire touching the tinfoil, is put through the box, and appears on the outside as in the figure. To this wire is fastened whatever is intended to communicate with the outside of the battery, as the piece of small wire in the figure; and the discharge is made by bringing the brass knob to any of the knobs of the battery. The glass of which this battery is made, is what the workmen call flint green, which Dr. Priestley thinks much better for this purpose than the best flint, as jars made of it are not so apt to discharge themselves; and it is moreover much cheaper.

In order to judge of the strength of a charge (which in large batteries is a matter of considerable consequence) apply the electrometer to the wires, from time to time. A comparison of the degree of the divergence of the balls, compared with the actual explosion, will soon enable the operator

rator to tell how high his battery is charged, and consequently what will be the force of the explosion.

You are not to conclude, because you can touch the wires of a large battery without any effect, that therefore, while your hand is upon them, you can safely touch the outside coating with the other hand; for sometimes when the wires have shown no signs of a charge, and even two days after the battery has been discharged, very violent shocks have been received. Therefore, soon after the first explosion, it is proper to discharge the residuum for fear of a disagreeable accident. When the box is very dry, there will sometimes remain even the residuum of a residuum, for several days.

The best construction of a fulmineous conductor, that is, a machine to draw down electricity or lightning from the clouds is as follows. On the top of any building which

will be more convenient if it stand on an eminence, erect a pole *a* (Plate III. Fig. 2.) as tall as a man can well manage, having on its top a solid piece of glass, or baked wood, a foot long; over which fix a tin or copper vessel *b*, in form of a funnel, to preserve it constantly from the rain; above this let there rise a long slender rod *c*, terminating in a pointed wire, and having a small wire twisted round its whole length, to conduct the electricity the better to the funnel. From the funnel let a wire *d*, descend along the building, at about a foot distance from it, and be conducted through an open fast, into the room that is most convenient for performing the experiments. In this room let a proper conductor be insulated, and connected with the wire that comes in at the window. This wire and conductor being completely insulated, will be electrified whenever there is a considerable quantity of electricity in the air: and notice will be given when it is properly charged,
either

either by the pith balls hung to it, or by such a set of bells as will be hereafter described.

To make experiments with this apparatus in perfect safety, the electrified wire should be brought within a few inches of a conducting rod, which serves to guard the house, that the redundant electricity may pass off that way, without striking any person who may chance to stand near it. The conductor to guard the house should consist of one rod, between one-fourth and one-half of an inch thick, if it be of iron, but smaller, if it be of brass or copper, and terminating upward in a sharp point, about four or five feet above the highest part of the building; and below, it should, if possible, be continued to some well or running water; if not, it should be sunk several feet into the ground, at the distance of some yards from the building. It is of no consequence whether this conducting rod be fastened to the

inside or outside of the house, or how many bendings there are in it.

Beside these principal parts of an electrical apparatus, the operator will frequently find it very convenient, when only small quantities of electricity are required, to be provided with tubes and cylinders of glass, and sticks of wax or sulphur.

Glass tubes should be made as long as a person can well draw through his hand at one stroke, that is about three feet, or something more, and as wide as can be conveniently grasped. It is not necessary that the glass be thick; perhaps the thinner the better, if it will bear sufficient friction, which, however, need be but very gentle, when the tube is in good order. It is most convenient to have the tube closed at one end; for the electric matter is not only thereby best retained on its surface, but the air may be more easily drawn out, or condensed in it, by means

of a brass cap fitted to the open end. A tube thus furnished is represented at *a*, Plate II. and is requisite for various experiments.

The best rubber for a smooth glass tube is the rough side of a black oiled silk, especially when a little amalgam of mercury and any metal, is put upon it. A little bees wax drawn over the surface of a tube will also greatly encrease its power. In rubbing a tube, the hand should be kept two or three inches below the upper part of the rubber, otherwise the electricity will discharge itself upon the hand, and nothing will remain upon the tube for the experiment. When the tube is in very good order, and strongly excited, it will throw off many pencils of rays at every stroke, without the approach of any conductor, except what moisture may float in the common atmosphere.

An electrician should also be furnished with rough glass tubes, that is, such as have their polish taken off; though a cylinder of baked wood will do nearly as well. The best rubber for a rough glass tube, or a cylinder of baked wood, as well as for a stick of wax or sulphur, is soft new flannel; or rather skins, such as hare or cat-skin, tanned with the hair on, being smoother, and having a more exquisite polish.

Such is the common construction of an electrical apparatus; but to make this part of our work correspond with the rest, by adding surprize to learning and ingenuity, it will be necessary to conceal the apparatus by placing it in an adjoining room. For which purpose, let the table *a, b, c, d*, (Plate III. Fig. 3.) be placed against the partition X, that separates the two rooms. Let the branch ABC be joined at A to the prime conductor in the other room: round the part A must be a piece of wood, baked
and

and prepared as is described, in the account of the apparatus; this piece must be made to take out, that it may be heated by the fire, in damp weather, before the exhibition begins, and must be nicely fitted to the waincot, that it may not occasion suspicion of any communication. The knob at C must be larger than usual, that it may give the larger snap. The branch being thus joined to the prime conductor, will answer all the purposes of the conductor itself, and larger snaps will be taken from C than from any part near the globe.

In each side of the top of the table between *ae* and *bf*, must be concealed a glass tube that communicates with the other room, and in these tubes must be placed the two chains that come from the two sides of a jar or battery, only one link of which, however, is to be seen at *e* and *f*, which may appear as hooks fastened to the table: to these hooks two other chains

chains or wires are to be fastened, when an explosion is wanted.

Certain words or phrases must be agreed on between the operator and his assistant, by which the latter may know when he is to charge the conductor, or connect the chains with the jar or battery. There should likewise be a small hole in the partition, by which he may guide himself with more certainty. Under the table may be a drawer, that may be pulled out occasionally, to show that there is nothing concealed.

To the foregoing apparatus it may be proper to add some account of the tourmalin, a substance that has been used in electric experiments but a few years past, but is supposed to be the lyncurium of the ancients, to which they attributed some electric properties. This stone is common in several parts of the East, and particularly

larly in the island or Ceylon, from whose inhabitants it received its present name *.

The tourmalin is a fossil of a hard and very compact substance, of a deep red colour, and pellucid. Its principal properties are thus described by Mr. Canton, in the Gentleman's Magazine for September 1759.

1. When the tourmalin is not electrical or attractive, heating it, without friction, will make it so; and the electricity of one side of it (distinguished by A) will be positive, and that of the other side (B) will be negative.

2. The tourmalin not being electrical, will become so by cooling; but with this difference, that the side A will be negative, and the side B positive.

3. If the tourmalin, in a non-electric

* Since the use of the tourmalin in electricity, it has been discovered that some other stones or gems, particularly the Brazil topaz, have similar properties.

state, be heated, and suffered to cool again without either of its sides being touched, A will be positive, and B negative, the whole time of the increase and decrease of its heat.

4. Either side of the tourmalin will be positive by friction, and both may be made so at the same time.

Mr. Canton observed farther, that it is not heat, but the circumstances of changing its degree of heat, that gives electricity to this stone.

Dr. Priestley has ingeniously remarked, that a pleasing deception might be made by enclosing a tourmalin, in a thin coat of sealing-wax; for the coat will then seem to have acquired the properties of the tourmalin.

We have been more minute in the description of this apparatus than may seem necessary to the performing the following
recre-

recreations ; but it is from the definitions and aphorisms, together with a description of the apparatus, that a knowledge of the several branches of science contained in this work, is to be acquired ; the recreations being principally intended to exemplify what is there laid down. Besides, a person of ingenuity, in possession of this electric apparatus, may invent a great number of similar recreations ; which being the produce of his own mind, will, perhaps, be found more entertaining than any here described ; and at the same time may, some of them, tend to the further eclclaircissement of this very pleasing branch of experimental philosophy.

ELECTRICAL RECREATIONS.

We shall divide these Recreations into such as are performed in the light, and such as require a dark chamber; beginning with the former.

RECREATION I.

The animated feather.

ELECTRIFY a smooth glass tube with a rubber, and hold a small feather (or piece of leaf gold) at a short distance from it. The feather will immediately fly to the tube, and adhere to it for a short time, and then fly off, and the tube can never be brought close to the feather till it has touched the side of the room, or some other body that communicates with the ground. If therefore the operator take care to keep the tube constantly between the feather and the side of the room, he may drive it round to all parts
without

without touching it; and what is very remarkable, the same side of the feather will be constantly opposite the tube.

While the feather is flying before the smooth tube, it will be immediately attracted by an excited rough tube, or a stick of wax, and fly continually from one tube to the other, till the electricity of both is discharged*.

This was one of the first, and is one of the most common experiments in electricity; it is however very entertaining, and shows the nature of electric attraction and repulsion altogether as well as a more elaborate performance.

* This feather not badly represents one of that despicable sort of women they call coquettes; who when an excited suitor appears, readily flies to him, but presently quits him. If another suitor appear, she in like manner flies to him, and in like manner leaves him: and then, unless a third party appear, is continually changing from one to the other; till at last they both grow tired of her, and she then remains as insignificant and contemptible as a mere feather.

RECRE-

RECREATION II.

The self-raising pyramid.

PROVIDE a large circular bundle of threads, of different colours, and let the threads be also of different lengths, increasing from the circumference to the center, where they are to be longest. Suspend this bundle from the middle of the brass arch between the pillars (Plate III. Fig. 3.) Then inform the company that the threads will rise up, at their command, in form of a pyramid, and continue in that form as long as they direct, and then return to their first position.

Therefore, when they command the threads to rise, you give the signal to the operator behind the partition, who, by turning the wheel, electrifies the arch, when the threads will immediately rise

up, in form of a pyramid, and continue so, as long as the operator continues turning the wheel, but when that stops they will immediately return to their former position.

RECREATION III.

The magical dance.

FROM the middle of the brass arch suspend three small bells, in the same manner they are suspended from the end of the conductor in Plate II. at *l*. The two outer bells hang by chains, and that in the middle by a silk string, while a chain connects it with the floor. Two small knobs of brass, which serve as clappers, hang, by silk strings, one between each two bells. Therefore when the two outer bells, communicating with the conductor, are electrified, they will attract the clappers, and be struck by them. The clappers being thus loaded with electricity,

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tricity, will be repelled, and fly to discharge themselves upon the middle bell; after which they will be again attracted by the outer bells: and thus, by striking the bells alternately, the ringing may be continued as long as the operator thinks proper*.

The music for your dance being thus provided, you are next to suspend a plate of metal from the same part of the arch to which the bells are connected: at the distance of a few inches from the arch, and exactly under it, place a metal stand of the same size, in the same manner as at *o* and *n* in Plate II. On the stand place several figures of men, other animals, or what you please, cut in paper or leaf

* In the dark a continual flashing of light will be seen between the clappers and the bells, and when the electrification is very strong, these flashes of light will be so large, that they will be transmitted by the clapper from one bell to the other, without its ever coming into actual contact with either of them; and consequently the ringing will cease.

gold,

gold, and pretty sharply pointed at both extremities*.

When the plate that hangs from the arch is electrified, the figures will dance with amazing rapidity, and the bells at the same time ringing incessantly, will afford no small entertainment to the spectators. This Recreation may be stopped and renewed at pleasure, in the same manner as the last.

* If a piece of leaf gold be cut with a pretty large angle at one extremity, and a very acute angle at the other, it will want no stand, but will hang, by its larger angle at a small distance from the conductor, and by the continual waving motion of its lower extremities, will have the appearance of something animated, biting or nibbling at the conductor. It is therefore called by Dr. Franklin the Golden Fish.

RECREATION IV.

The artificial spider.

CUT a piece of burnt cork, about the size of a pea, into the form of the body of a spider; make its legs of linen thread, and put a grain or two of lead into it to give it more weight. Suspend it by a fine line of silk between the electrified arch and an excited stick of wax, and it will, like a clapper between two bells, jump continually from one body to the other, moving its legs at the same time, as if animated; to the no small surprize of those who are unacquainted with the electric influence*.

* This is an American invention, and was first described by Dr. Franklin.

RECREATION V.

The marvellous fountain.

SUSPEND a vessel of water from the middle of the brass arch, and place in the vessel a capillary syphon. The water will at first issue by drops only, from the lower leg of the syphon, but when the wheel is put in motion, there will be one continued stream of water, and if the electrification be strong, a number of streams, will issue, in form of a cone, the top of which will be at the extremity of the tube. This experiment may be stopped and renewed, almost instantly, at the word of command.

This Recreation may be diversified by having one of those fountains that are made by condensed air, as will be described under the article of Hydraulics: the fountain is to be insulated, when it will pour forth one stream only, but on being electrified, that one stream will be divided in-

to a thousand, and dispersed over a large space of ground. You may here command either the single, or the divided stream, at pleasure, by only laying your finger on the arch, or taking it off. The streams from both these fountains will appear quite luminous in the dark.

RECREATION VI.

The magic picture.

HAVE a large print, suppose of the king, with a frame and glass *. Cut a pannel out of the print at about two inches from the frame all round: with thin paste, or gum, fix the border that is cut off, on the inside of the glass, pressing it smooth and close, then fill up the vacancy, by covering the glass well with leaf gold, or thin tin-foil, so that it may lie close. Cover likewise the inner

* This experiment was invented by Mr. Kinnersley, the author of many other improvements in electricity.

edge of the bottom part of the back of the frame with the same tin-foil, and make a communication between that and the tin-foil in the middle of the glass; then put in the board, and that side is finished. Turn up the glass and cover the fore-side with tin-foil, exactly over that on the back-side, and when it is dry, paste over it the pannel of the print that was cut out, observing to bring the corresponding parts of the border and pannel together, so that the picture will appear as at first, only part of it behind the glass, and part before. Lastly hold the print horizontally by the top, and place a little moveable gilt crown on the king's head*.

Now if the tin-foil on both sides of the glass be moderately electrified, and another person take hold of the bottom of the frame with one hand, so that his fingers

* If you have not the figure of a crown, a guinea or a shilling will shew the experiment equally well.

touch the tin-foil, and with the other hand endeavour to take off the crown, he will receive a very smart blow, and fail in the attempt. The operator who holds the frame by the upper end, where there is no tin-foil, feels nothing of the shock, and can touch the face of the king without danger, which he pretends to be a test of his loyalty. When a ring of persons take a shock among them, the experiment is called the conspirators.

RECREATION VII,

The Tantalian cup.

PLACE a cup or pot, of any sort of metal, on a stool of baked wood, or a cake of wax. Fill to the brim with any sort of liquor: let it communicate with the branch by a small chain, and when it is moderately electrified, desire a person to taste the liquor, without touching the cup with his hands, and he will immediately receive a shock at his lips; which,

RECREATIONS. 57

which, however, should not be very strong.

The motion of the wheel being stopped, you offer to taste the liquor yourself, and desire the rest of the company to taste it likewise, which they will do without any inconvenience. You then give the signal to the operator, and while you are amusing the company with discourse, the cup is again charged, and you desire the same person a second time to taste the liquor, when, to the no small diversion of the company, he will receive a second shock,

RECRE-

RECREATION VIII.

The circular chimes.

LET a small upright shaft of wood pass at right angles, through a thin round board, of about twelve inches diameter, and let the shaft turn on a sharp point of iron fixed in the lower end; while a strong wire in the upper end, passing through a small hole in a thin brass plate, keeps the shaft truly vertical. About 30 radii, of equal length, made of flash glass, cut in narrow slips, are to issue horizontally from the circumference of the board; the ends most distant from the center being about four inches asunder, and on the end of every one of them is fixed a brass thimble. If a wire fixed to either of the links at *e* or *f*, (Plate III. Fig. 3.) while the other end of the chain communicates with the wire of a bottle electrified in the common way, be brought near the circumference of the wheel, it will attract the nearest thim-

thimble, and so put the wheel in motion. That thimble, in passing by receives a spark, and being thereby electrified, is repelled, and so driven forward, while a second thimble, being attracted, approaches the wire, receives a spark, and is driven after the first, and so on, till the wheel has gone once round; when the thimbles before electrified approaching the wire, instead of being attracted as they were at first, they are repelled, and the motion presently ceases.

But if a wire communicating with the other chain, that is connected with another bottle charged through the coating, be brought near the same wheel, it will attract the thimble repelled by the first, and thereby double the force that carries the wheel round; and not only taking out the fire that had been communicated by the thimbles to the first wire, but even robbing them of their natural quantity; instead of being repelled when they come again
toward

toward the first wire, they are most strongly attracted; so that the wheel mends its pace, till it goes with great rapidity, twelve or fifteen rounds in a minute, and with such strength, that the weight of four or five pounds, when laid on it, does not visibly retard its motion*.

* This part of the machine is sometimes called an electrical jack: for if a large fowl be spitted on the upper shaft, it will be carried round with a motion fit for roasting; and it appears from one of Dr. Franklin's letters, that it has been actually applied to this purpose. "In the year 1748, the hot weather coming on, when electrical experiments were not so agreeable, we put an end to them for that season, says the doctor, somewhat humourously, in a party of pleasure on the banks of the Skuylkil. First, spirits were fired by a spark sent from side to side through the river, without any other conductor than the water. A turkey was killed for our dinner by an electrical shock, and roasted, by the electrical jack before a fire kindled by the electrical bottle; and the healths of all the famous electricians in England, Holland, France, and Germany, were drank in electrified bumpers, under a discharge of guns from the electrical battery." Franklin's Letters, p. 35.

Now if a radius of baked wood, of about eight inches, be fixed in the upper shaft, and a number of small bells, corresponding to the notes of a tune, be placed on pillars, and fixed in two semicircular stands, at a proper distance from the thimbles, when the wheel turns round, the radius will strike against the bells, and consequently play the tune; and as the celerity of the wheel is continually altering, so will be the time, or duration of the notes. It is to be observed, that the two semicircles in which the bells are fixed, must not be brought within reach of the radius till the wheel has acquired a considerable velocity, for otherwise they will at least check, if not totally stop, its motion. If the stroke of the wooden radius do not give a tone sufficiently acute, a piece of solid glass may be fixed to the end of it.

If a greater variety of tones is required, there may be two sets of bells, one for the treble and the other for the base. The
bells

bells may likewise be made to take out of the stand, so as to perform different tunes by being placed in different positions.

RECREATION IX.

The self-moving wheel.

THIS wheel, though constructed on the same principles with the foregoing, appears still more surprising. It is formed of a thin round plate of window-glass, 17 inches diameter, well gilt on both sides, all but two inches next the edge. Two small hemispheres of wood are then fixed with cement to the middle of the upper and under sides, centrally opposite, and in each of them a thick strong wire, eight or ten inches long, which together make the axis of the wheel. It turns horizontally, on a point at the lower end of its axis, which rests on a bit of brass cemented within a glass salt-cellar. The upper end of its axis passes through
a hole

a hole in a thin brass plate, cemented to a long and strong piece of glass, which keeps it six or eight inches distant from any non-electric, and has a small ball of wax or metal on the top, to keep in the fire.

In a circle on the table which supports the wheel, are fixed twelve small pillars of glass, at about eleven inches distance, with a thimble on the top of each. On the edge of the wheel is a small leaden bullet, communicating by a wire with the gilding of the upper surface of the wheel; and about six inches from it is another bullet, communicating, in like manner, with the under surface. When the wheel is to be charged by the upper surface, a communication must be made from the under surface to the table.

When it is well charged it begins to move. The bullet nearest to a pillar moves towards the thimble on that pillar, and
passing

passing by, electrifies it, and then pushes itself from it. The succeeding bullet, which communicates with the other surface of the glass, more strongly attracts that thimble, on account of its being electrified before by the other bullet, and thus the wheel increases its motion, till it is regulated by the resistance of the air. It will go half an hour, and make, one minute with another, 20 turns in a minute, which is 600 turns in the whole. The bullet of the upper surface gives in each turn 12 sparks to the thimbles, which makes 7200 sparks; and the bullet of the under surface receives as many from the thimbles, those bullets moving in the same time 2500 feet. The thimbles are well fixed, and in so exact a circle, that the bullets may pass within a very small distance of them.

If instead of two bullets, you put eight, four communicating with the upper surface,

face, and four with the under surface, placed alternately (which eight, at about six inches distance, complete the circumference), the force and celerity will be greatly increased; the wheel making 50 turns in a minute: but then it will not continue so long in motion.

RECREATION X.

The magician's chace.

ON the top of a finely pointed wire, rising perpendicularly from the conductor, let another wire, sharpened at each end, be made to move freely, as on a center. If it be well balanced, and the points be bent horizontally, in opposite directions, it will, when electrified, turn very swiftly round, by the re-action of the air against the current which flows from off the points. These points may be nearly concealed, and the figures of men and horses, with hounds and a hare or fox,

may be placed upon the wires so as to turn round with them, when they will look as if the one pursued the other*. If the number of wires proceeding from the same center be increased, and a still greater variety of figures be put upon them, the chace must be more diversified and entertaining. If the wire which supports the figures have another wire finely pointed, rising from its center, a second set of wires, furnished with another sort of figures, may be made to revolve above the former, and either in the same or the contrary direction, as the operator shall think fit.

If such a wire, pointed at each end, and the ends bent in opposite directions, be furnished like a dipping needle, with a small axis fixed in its middle, at right an-

* This is also an invention of Mr. Kinnerfley, and is called by him, when the figures of horses only are used, the electrical horse-race.

gles with the bending of the points, and the same be placed between two insulated wire strings, near and parallel to each other, so that it may turn on its axis, freely upon and between them, it will, when electrified, have a progressive as well as circular motion, from one end of the wires that support it to the other; and this even up a considerable ascent.

RECREATION XI.

The planetarium.

FROM the branch suspend six concentric hoops of metal, at different distances from each other; and under them, on a stand, place a metal plate, at the distance of about half an inch. Then place upon the plate, within each hoop, and near to it, a round glass bubble, blown very light; these bubbles and the distances between the hoops should correspond to the different diameters of the planets, and

those of their orbits; but as that cannot be on account of the vast disproportion between them, it must suffice here to make a difference that bears some relation to them.

Now the hoops being electrified, the bubbles placed upon the plate, near the hoops, will be immediately attracted by them; in consequence of which, that part of a bubble which touches a hoop will acquire some electric virtue, and be repelled: the electricity not being diffused over the whole surface of the glass, another part of the surface will be attracted, while the former goes to discharge its electricity upon the plate. This will produce a revolution of the bubble quite round the hoop, as long as the electrification is continued, and will be either way, just as the bubble happens to set out, or is driven by the operator. A ball hung over the center of all the hoops will serve to represent

present the sun in the center of its system. If the room be darkened the several glass balls will appear beautifully illuminated. This experiment affords a remarkable instance of electric attraction and repulsion.

RECREATION XII.

The incendiaries.

LET a person stand upon a stool made of baked wood, or upon a cake of wax, and hold a chain communicating with the branch. Upon turning the wheel he will soon become electrified; his whole body, in reality, making a part of the prime conductor, and will exhibit the same appearances; emitting sparks wherever he is touched by any person standing on the floor. If the prime conductor be very large, the sparks may be rather painful than agreeable; but if it be small, the electrification moderate, and none of the

company touch the eyes, or the more tender parts of the face, the experiment is diverting enough to all parties.

Many of the preceding experiments may also be performed to advantage by a person standing upon the stool as above, and holding in his hand what was directed to be fastened to the prime conductor. If he hold a large plummy feather in his hand, it is very pleasing to observe how it becomes turgid, its fibres extending themselves in all directions from the rib; and how it shrinks like the sensitive plants, when any unelectrified body touches it; when the point of a needle is presented to it, or to the prime conductor with which he is connected.

If a dish, containing spirits of wine made warm, be brought to the electrified person, and he be directed to put his finger, or a rod of iron into it, the spirit will

will be immediately in a blaze; and if there be a wick or thread in the spirit, that communicates with a train of gunpowder, he may be made to blow up a magazine, or set a city on fire with a piece of cold iron; and at the same time know nothing of what he is about.

A recreation of this sort may be performed by several persons, that all stand upon insulated stools, and many diverting circumstances may be added to those here mentioned. Care should be taken that the floor on which the stools stand be free from dust, but it is most eligible to have a large smooth board for that purpose.

RECREATION XIII.

The inconceivable shock.

PUT into a person's hand a wire that is fixed on to the hook that comes from the chain which communicates with one side of the battery, and in his other hand put a wire with a hook at the end of it, which you direct him to fix on to the hook that comes from the other chain, which when he attempts he will instantly receive a shock through his body, without being able to guess from whence it proceeds. The shock will be in proportion to the number of jars that are charged; but it is remarkable, that a small shock gives a much more pungent sensation in passing through the body, than one that is large*.

* The shock may be made to pass through any particular part of the body, without much affecting the rest, if that part, and no other, be brought into the circuit through which the fire must pass from one side of the jar or battery to the other.

This recreation may be diversified, and rendered still more entertaining, by concealing the chain that communicates with that which comes from the outside of the battery, under a carpet, and placing the wire that communicates with the chain which comes from the inside, in such manner that a person shall put his hand upon it without suspicion, at the same time that his feet are upon the other wire. Many other methods of giving a shock by surprise may be easily contrived; but great care should be taken that these shocks be not too strong, and that they be not given to all persons indiscriminately.

When a single person receives a shock, the company is diverted at his sole expence; but all contribute their share to the entertainment, and all partake of it alike, when the whole company forms a circle, by joining their hands, and when the operator directs the person who is at one extremity of the circle to hold the chain

chain which communicates with the coating, while he who is at the other extremity of the circle touches the other chain or wire. All the persons who from this circuit being struck at the same time, and with the same degree of force, it is often very pleasant to see them all start at the same moment, to hear them compare their sensations, and observe the very different accounts they give*.

This experiment may be agreeably varied, if the operator, instead of making the company join hands, directs them to tread on each other's toes, or lay their hands on each other's heads. If in the latter case the whole company should be struck to the ground, as it once happen-

* M. Monnier of Paris is said to have communicated this shock through a line of men, and other conductors, of 900 toises, that is, more than an English mile ; and Abbé Nollet performed the same experiment upon 200 persons, ranged in two parallel ranks. Our countryman Mr. Walker has electrified two regiments of soldiers at once.

ed when Dr. Franklin gave the shock to six very stout men, the inconvenience arising from it will be very little; the company that was struck in this manner neither heard nor felt the stroke, and immediately got up again, without knowing what had happened. This stroke was given with two large jars, each of the measure of about six gallons, but not fully charged.

RECREATION XIV.

Magical explosions.

WE have shewn in a preceding recreation how gunpowder may be fired by the intervention of spirits, but there is another method, more simple and expeditious, which we shall here describe. Make up gunpowder in the form of a small cartridge, in each end of which put a blunt wire, so that the ends within the cartridge may be about half an inch distant from

from each other, then joining the chain that comes from one side of the battery to one of the wires at the end of the cartridge, bring the chain that comes from the other side of the battery, to the wire at the other end, when the shock will instantly pass through the powder, and set it on fire.

By a similar method fine brass or iron wire may be melted; for the explosion will pass from one chain to the other, through the wire, which will be first red hot, and then melt into round drops*. A battery of 35 jars has entirely destroyed fine brass wire, of the 330th part of an inch in diameter, so that no particle of it could be found after the explosion. At the moment of the stroke, a great number of

* The power of a battery to melt wire is different at different distances. Dr. Priestley found that he could melt nine inches of small iron wire at the distance of 15 yards, but at 20 yards distance he could only make six inches red hot.

sparks, like those from a flint and steel, flew upward and laterally from the place where the wire was laid, and lost their light, in the day, at the distance of about two or three inches*.

A stroke from a common jar will easily strike a hole through a thick cover of a book, or many folds of paper, leaving a remarkable bur or prominence on both sides, as if the fire had darted both ways from the center.

* The late Mr. Canton, by whose ingenuity and industry this branch of philosophy received very great improvement, clearly proved, that pure gold and silver might be calcined by the electric explosion, and be converted into numberless globules of glass, some of which were transparent, and others tinged with a great variety of colours.

RECREATION XV.

The prismatic colours.*

TO the ends of each of the chains that come from the battery, fix an iron wire, and between those wires place a plate of tin, of about three inches square, and polished on one side †, in a perpendicular direction. The wire next the polished side should be finely pointed, and brought very near the surface of the plate.

By repeating the explosions of the battery, there will first appear a dusky red,

* This discovery was made by Dr. Priestley, and serves to confirm the Newtonian doctrine of the difference of colours in bodies arising from the different densities of the fine plates that compose the surfaces.

† The polish is not necessary, but the colours appear more beautiful than on a rough surface. This experiment may be made equally well with the other metals, as gold, silver, copper, brass, iron, or lead.

about

about the edge of the central spot; presently after, generally after four or five strokes, there appears a circular space, visible only in an oblique position to the light, and looking like a shade on the plate: this expands very little during the whole course of the explosions. After a few more discharges, the second circular space is marked, by another shade beyond the first, of one-eighth or one-tenth of an inch in width, which never changes its appearance after any number of explosions. All the colours make their first appearance about the edge of the circular spot; more explosions make them expand toward the extremity of the space first marked out; while others succeed in their place, till after 30 or 40 explosions, three distinct rings appear, each consisting of all the colours in the prism or rainbow.

It makes no difference whether the electricity issue from the pointed wire

upon the plate, or from the plate upon the pointed wire, the surface opposite the point being marked exactly the same in both cases. The points themselves, from which the fire issues, or at which it enters, are coloured for about half an inch to a considerable degree, and the colours are repeated, as on the plate.

The innermost, that is, the last formed colours, on the plate, are always the most vivid, and those rings are also closer to each other than the rest. These colours may be brushed with a feather or the finger without injury, but they are easily peeled off by the nail, or any thing that is sharp.

RECREATION XVI.

The artificial earthquake.

IN the middle of a large basin of water place a round wet board: this board represents the earth, and the water the sea. On the board erect an edifice, composed of several separate pieces, which may represent a church, a castle, a palace, or if you please all of them.

Then placing a wire that communicates with the two chains of the battery, so that it may pass over the board and the surface of the water, upon making the explosion, the water will become agitated, as in an earthquake, and the board moving up and down, will overturn the structures it supports; at the same time that the cause of this commotion is totally concealed.

This experiment likewise was invented by Dr. Priestley, and when well executed, cannot fail to give great surprize as well as entertainment.

R E C R E A T I O N XVII.

The electrical kite.*

TAKE a large thin silk handkerchief, and extend it, by fastening the four corners to two flight strips of cedar. The handkerchief thus prepared and accommodated with a tail, loop and string, will rise in the air as a common paper kite. To the top of the upright stick of the cross is to be fixed a pretty sharp-pointed wire, rising a foot or more above the wood. To the end of the twine next the hand is to be tied a silk ribband, and where the twine and silk join, a key or tin tube may be fastened.

* This is an invention of Dr. Franklin.

This kite is to be raised when a thunder gust appears to be coming on, and as soon as the thunder clouds come over the kite, the pointed wire will draw the electricity from them, and the kite, with all the twine, will be electrified, the loose filaments of the twine will stand out every way, and be attracted by the finger. When the rain has wetted the kite and twine, so that it can conduct the electric fire freely, it will stream out plentifully from the key, on the approach of a man's knuckle. At this key a phial may be charged, and from the electric fire thus obtained, spirits may be kindled, and all the other experiments performed.

The greatest quantity of electricity that was ever brought from the clouds by an apparatus, was by M. de Romas, of Nerac, in the South of France. This gentleman was the first who made use of a wire interwoven in the hempen cord of an electric kite, which was seven feet and a half high,

and three feet wide, so that it contained 18 square feet of surface. This cord was found to conduct the electricity of the clouds more powerfully than a hempen cord, even though it was wetted; and being terminated by a cord of dry silk, it enabled the observer (by a proper management of his apparatus) to make whatever experiments he thought proper, without danger.

By the help of this kite, on the 7th of June, 1753, about one in the afternoon, when it was raised 550 feet from the ground, and had taken 780 feet of string, making an angle of near 45 degrees with the horizon, he drew sparks from his conductor three inches long, and a quarter of an inch thick, the snapping of which was heard 200 paces *. While he was taking these sparks, he felt as it were, a sort of cobweb on his face, though he was more than three feet from the string of the

* That is, being the half way between the horizon and the point directly over the spectator's head.

kite: after which he did not think it safe to stand so near, and called aloud to all the company to retire, as he did himself about two feet.

Thinking himself now secure enough, and not being incommoded by any body very near him, he took notice of what passed among the clouds that were immediately over the kite. There was no appearance of lightning there, or any where else, nor scarce the least noise of thunder, and no rain at all. There was a pretty strong wind at west, which raised the kite at least 100 feet higher than in any other experiment. Casting his eyes afterwards on the tin tube fastened to the string of the kite, and about three feet from the ground he saw three straws, one of which was about a foot long, a second four or five inches, and the third three or four inches, all standing erect, and performing a circular dance, like puppets, under the tin tube, without touching each other.

This little spectacle, with which several of the company were much delighted, lasted about a quarter of an hour; after which some drops of rain falling, he again perceived the sensation of the cob-web on his face, and at the same time heard a continual rustling noise, like that of a small forge bellows. This was a farther warning of the increase of electricity, and from the first instant M. De Romas perceived the dancing straws, he thought it not advisable to take any more sparks, even with all his precautions; and he again intreated the company to retire to a still greater distance.

Immediately after this came on the last act of the entertainment, which M. De Romas acknowledges made him tremble. The longest straw was attracted by the tin tube, upon which there followed three explosions, the sound of which greatly resembled that of thunder. Some of the company compared it to the explosion of rockets,

rockets, and others to the violent crashing of large earthen jars against a pavement. It is certain that it was heard into the heart of the city, notwithstanding the various noises there.

The fire that was seen at the instant of explosion had the shape of a spindle, eight inches long, and five lines in diameter. But the most astonishing and diverting circumstance was produced by the straw, which had occasioned the explosion, following the string of the kite. Some of the company saw it at 45 or 50 fathoms distance, attracted and repelled alternately, with this remarkable circumstance, that every time it was attracted by the string, flashes of fire were seen, and cracks were heard, though not so loud as at the time of the former explosion.

It is remarkable, that from the time of the explosion, to the end of the experiment, no lightning at all was seen, and scarce

any thunder heard. A smell of sulphur was perceived, much like that of the luminous electric effluvia issuing from the end of an electrified bar of metal. Round the string appeared a luminous cylinder of light, three or four inches diameter ; and as this was in the day time, M. de Romas did not question but that if it had been in the night, the electric atmosphere would have appeared to be four or five feet in diameter. An end was put to these remarkable experiments, by the wind's shifting to the east, and rain mixed with hail, coming on in great plenty*.

* The quantity of electric matter brought by this kite from the clouds at another time is really astonishing. August 26, 1756, the streams of fire issuing from it were observed to be an inch thick, and ten feet long. These amazing flashes of lightning, whose report was equal to that of a pistol, and whose effect, had any of them struck on buildings or animal bodies, would perhaps have been equally destructive with any mentioned in history, were safely conducted by the cord of the kite to a non-electric body placed near it.

As

As the foregoing account might deter some persons from attempting this very entertaining experiment, especially when there is the appearance of an approaching thunder-storm, we shall here add an apparatus, invented by Dr. Priestley, and with which he thinks there can be no great danger in any thunder-storm.

Let the string *a* of a kite (Plate III. Fig. 4.) be wound upon a reel *b*, going through a slit in a flat board, fastened at the top of it; by which more or less of the string may be let out at pleasure. Let the reel be fixed to the top of a tin or copper funnel *c*, and from the funnel let a metal rod *d*, with a large knob, be projected, to serve as a conductor. This funnel and reel must be supported by a staff *e*, the upper end of which, at least, must be well baked, and the lower end may be made sharp, to thrust into the ground, when the kite is well raised.

The

The safety of this apparatus depends on the chain *f*, fastened to the staff by a hook a little below the funnel, and dragging on the ground: for the redundant lightning will strike from the funnel to the chain, and so be conducted as far as is desired, without touching the person who holds the staff.

Sparks may be taken from the conductor of this apparatus with all safety, by means of a small rod of baked wood *g*, furnished with a small funnel *b*, a brass rod *i*, and a chain *k*, connected with it, for the lightning which strikes the rod, will pass by the funnel and the chain, without touching the person who holds the rod.

Fig. 4. p. 89.

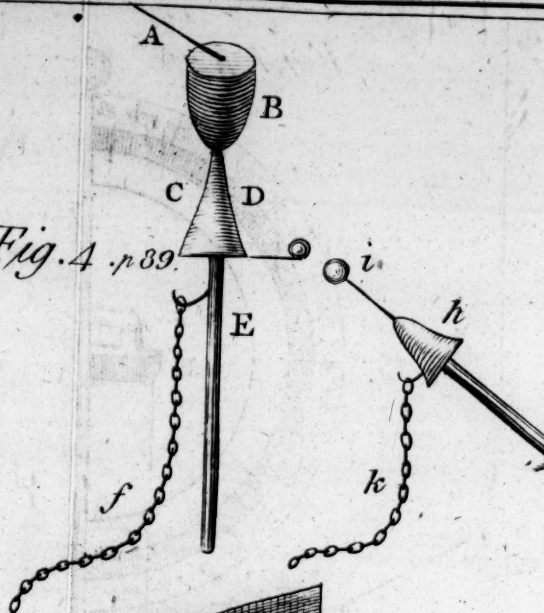


Fig. 3. p. 40.

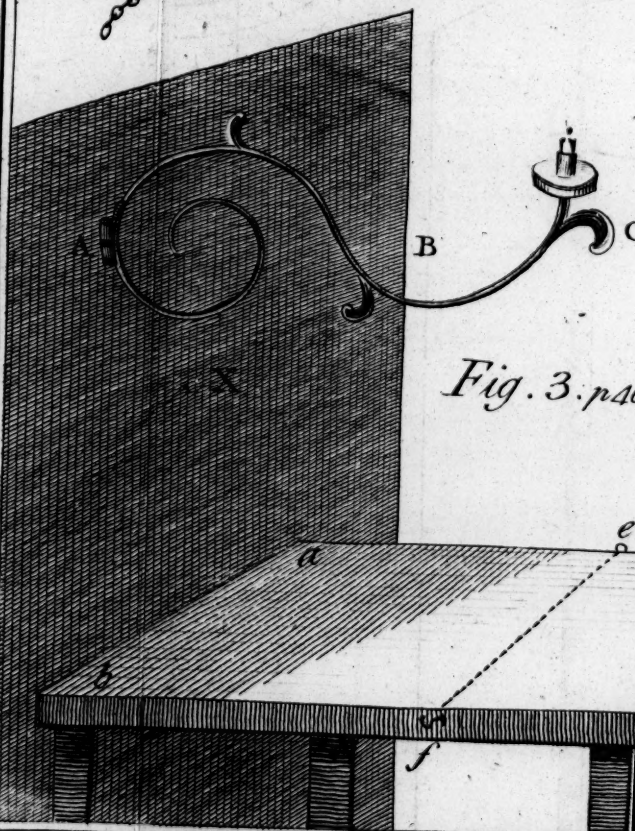


Fig. 1. p. 29.

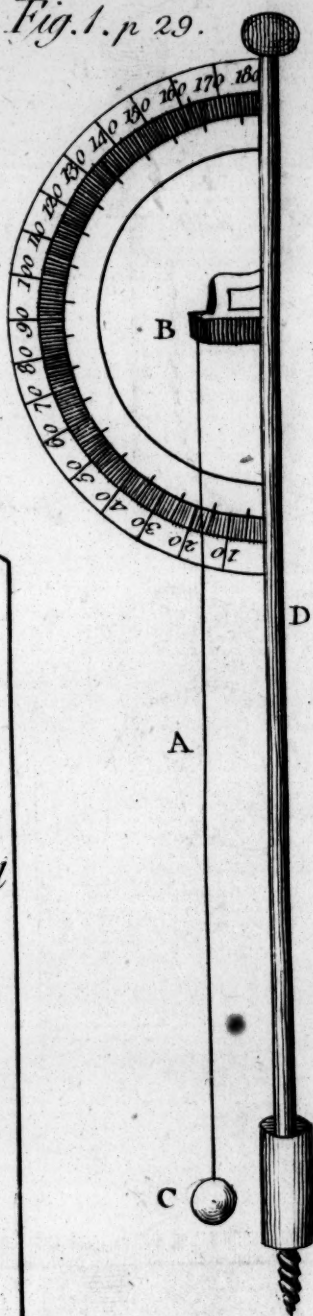
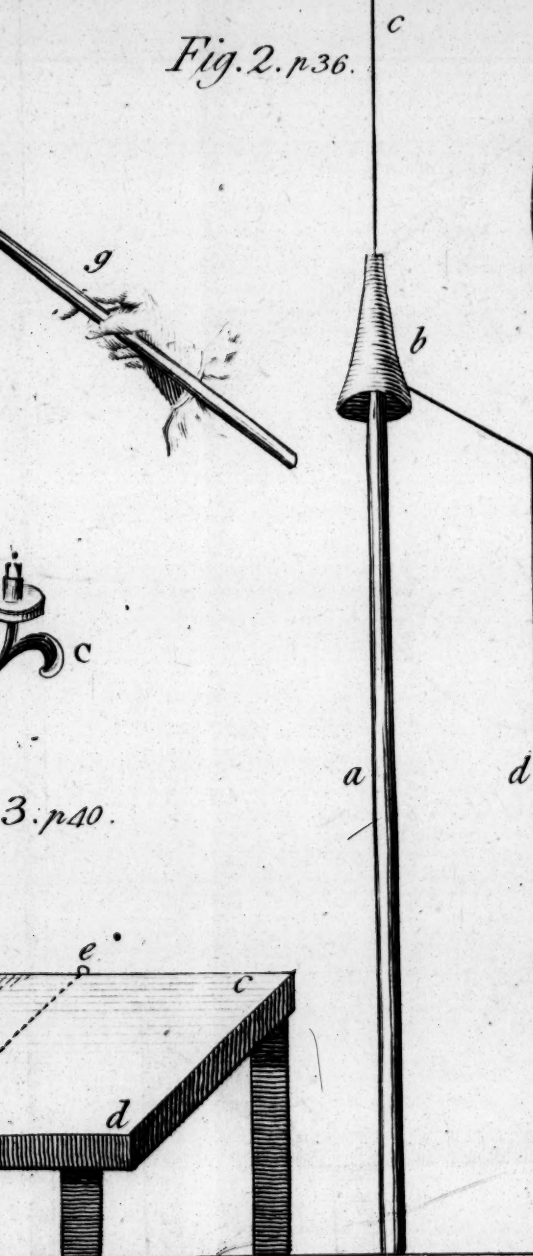
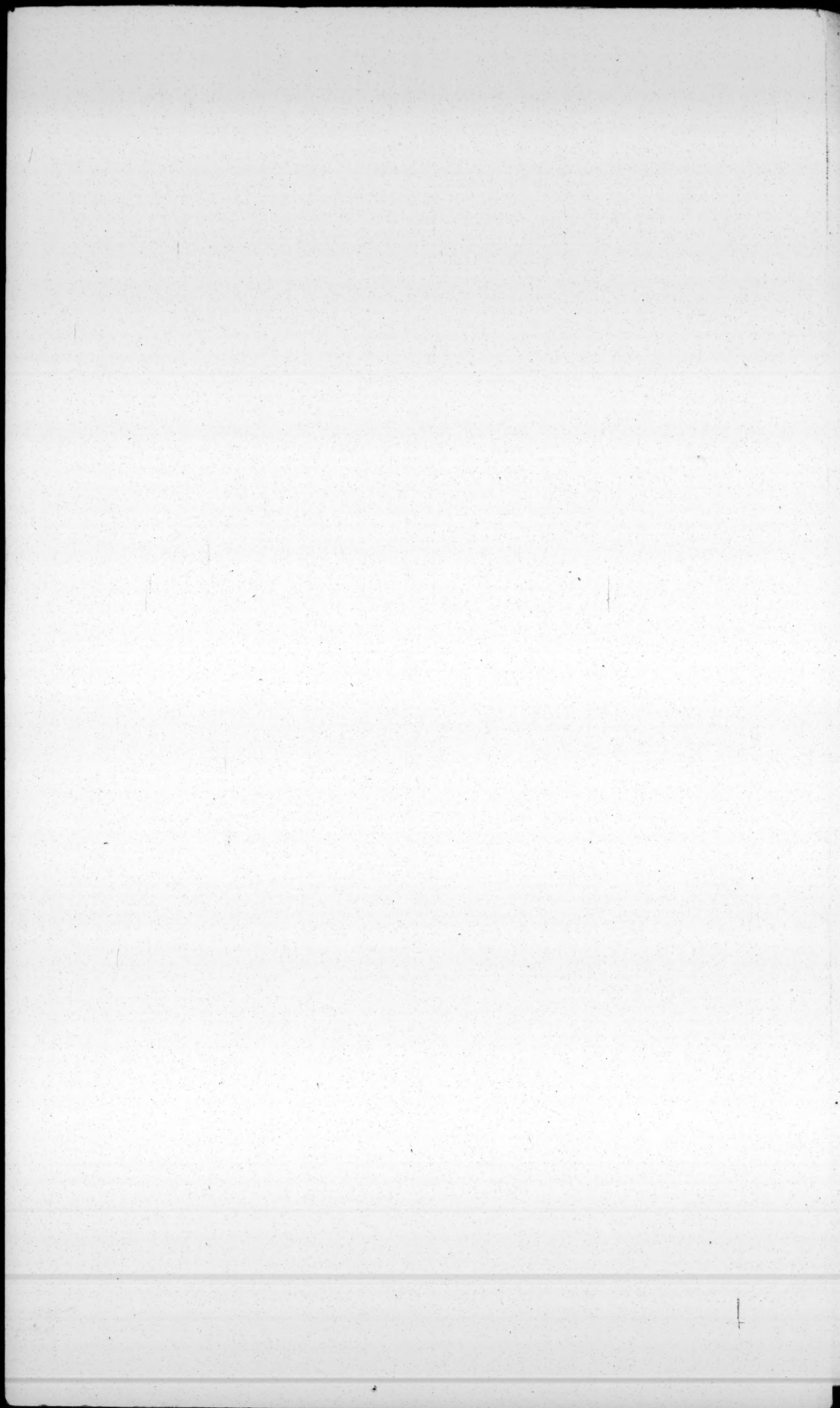


Fig. 2. p. 36.





RECREATIONS IN THE DARK CHAMBER.

To exhibit a great number of pleasing and surprising recreations in the dark, as well as in the light, is the peculiar property of electricity; for though there are many beautiful experiments performed in the camera obscura, it is still by the aid of the sun's rays, or those of a candle or lamp: whereas the electric apparatus contains within itself those particles of fire by which these recreations are performed,

RECREATION XVIII.

The miraculous luminaries.

TO perform this recreation it is necessary to be provided with a quantity of the following phosphorus. Calcine common oyster-shells, by burning them in the fire for about half an hour; then beat them into powder, of the clearest
of

of which take three parts, and of flowers of sulphur one part, and put the mixture into a crucible about one inch and a half deep. Let it burn in a strong open fire, for a full hour; when cool, turn it out, and break it into several pieces; and taking those pieces into a dark place, scrape off the brightest parts for use, which, when good, will be a white powder,

Then take a circular board of three or four feet diameter, on the center of which draw the figure of the half moon, of three or four inches diameter, and round it, at different distances, draw a number of stars, of different magnitudes. On each of these figures fix the phosphorus just mentioned, to the thickness of about a quarter of an inch. The board being thus prepared, you must have ready a number of charged jars, or phials, and by discharging one of them, at the distance of about an inch, over each figure, it will become illuminated. The light of the crescent will be so strong

at first, that you may distinguish by it the figures on the dial of a watch. Round the board let there be placed a rim or hoop, and over that, at a sufficient distance from the figures, draw a curtain.

The board thus prepared is to be brought into the darkened room, and placed, by hooks, against the ceiling. The curtain is then to be drawn back, and the moon and stars will appear as emerging from behind a cloud, and will continue to shine for half an hour; the light, however, growing continually more faint.

Previous to the performing the following recreation, it will be necessary to have a globe and cushion placed on the middle of the table, which must communicate, by a string that goes through the partition, with the wheel in the other room.

RE-

RECREATION XIX.

The globular fires.

LET the room, and all the parts of the apparatus, be made very dry, and let the globe be strongly excited, so that the electricity may be very vigorous; the fire will then be seen to dart from the cushion toward the fire of the conductor. Sometimes these lucid rays (which are in part visible in day-light) will make the circuit of half the globe, and reach the wires; and they will frequently come in a considerable number, at the same time, from different parts of the cushion, and reach within an inch or two of the wires. The noise attending this beautiful phenomenon exactly resembles the crackling of bay leaves in the fire. These lucid arches have frequently radiant points, often four or five in different parts of the same arch. These radiant points are intensely bright, and

and appear very beautiful. It is peculiarly pleasing to observe the circles of fire rise from those parts of the cushion, where the amalgam or moisture has been put, or which have been lately scraped. Single points on the rubber will then appear intensely bright, and for a long time together will seem to pour out continual torrents of flame. If one part of the rubber be pressed closer than another, the circles will issue from that part more frequently than from any other.

When the conductor is taken quite away, circles of fire will appear on both sides the rubber, which will sometimes meet and completely encircle the globe. If in that state a finger be brought within half an inch of the globe, it is sure to be struck very smartly; and there will often be a complete arch of fire from it to the rubber, though it be almost quite round the globe.

If

If all the air be exhausted from the globe, the electricity will be found to act wholly within it, where it will appear in the form of a cloud or flame of reddish or purple-coloured light, filling the whole interior space of the globe *.

RECREATION XX.

The luminous shower.

ON the plate at *n*, Plate II. put a number of seeds of any kind; or grains of sand, or a quantity of brass dust. The conductor being strongly electrified, those light particles will be attracted and repelled by the plate *o*, suspended from the conductor, with amazing rapidity, so as to exhibit a perfect luminous shower.

* When this recreation is finished, the globe and rubber must be taken away, that they may not incommode the apparatus of the following experiments.

Another,

Another method of representing luminous rain, is by a sponge that has been immersed in water. When this sponge is first hung to the conductor, the water will drop from it very slowly; but when it is electrified, the drops will fall very fast, and will appear like globules of fire, illuminating the basin into which they fall.

RECREATION XXI.

The illuminated vacuum.

TAKE a tall receiver that is very dry, and through the top of it fix, with cement, a wire, not very acutely pointed. Then exhaust the receiver, and present the knob of the wire to the conductor, and every spark will pass through the vacuum, in a broad stream of light, visible through the whole length of the receiver, how tall soever it be. This stream often divides itself into a variety of beautiful rivulets, which are continually changing their

VOL. III. H course,

course, uniting and dividing again in a most pleasing manner. If a jar be discharged through this vacuum, it gives the appearance of a very dense body of fire, darting directly through the center of the vacuum, without ever touching the sides; whereas, when a single spark passes through, it generally goes more or less to the side, and a finger put to the outside of the glass, will draw it wherever a person please. If the vessel be grasped by both hands, every spark is felt, like the pulsation of a large artery, and all the fire makes towards the hands. This pulsation is felt at some distance from the receiver, and a light is seen between the hands and the glass.

All this while the pointed wire is supposed to be electrified positively; if it be electrified negatively, the appearance is remarkably different. Instead of streams of fire, nothing is seen but one uniform luminous appearance, like a white cloud, or

the milky way in a clear star-light night. It seldom reaches the whole length of the vessel, but generally appears only at the end of the wire, like a lucid ball.

If in the neck of a tall receiver a small phial be inserted, so that the external surface of the glass may be exposed to the vacuum, it will produce a very beautiful appearance. The phial must be coated on the inside, and while it is charging, at every spark taken from the conductor into the inside, a flash of light is seen to dart, at the same time, from every part of the external surface of the phial, so as to quite fill the receiver. Upon making the discharge, the light is seen to return in a much closer body, the whole coming out at once.

RECREATION XXII.

The luminous cylinder.*

PROVIDE a glass cylinder three feet long and three inches diameter: near the bottom of it fix a brass plate, and have another brass plate so contrived that you may let it down the cylinder, and bring it as near the first plate as you desire. Let this cylinder be exhausted and insulated, and when the upper part is electrified, the electric matter will pass from one plate to the other, when they are at the greatest distance from each other the cylinder will admit. The brass plate at the bottom of the cylinder will moreover be as strongly electrified, as if it was connected by a wire with the prime conductor.

The electric matter in its passage thro' this vacuum is said to produce a delightful

* This is an invention of Dr. Watson.

spectacle; not making, as in the open air, small brushes or pencils of rays, an inch or two in length, but corruscations of the whole length of the tube, and of a bright silver hue. These do not immediately diverge as in the open air, but frequently form a base that is apparently flat, dividing themselves into less and less ramifications, and very much resemble the most lively corruscations of the aurora borealis.

RECREATION XXIII.

The magical constellations.

AS the moon and stars in the zenith will become dull during the time of performing the preceding recreations, it will be proper to draw the curtain gently before them, that it may seem as if a cloud came slowly over them; and then the operator may, by his magical power, light up other constellations. In order to which,

H 3

he

he must provide a large board, on which let him mark the stars that are in two or more constellations, which are contiguous and visible in the northern hemisphere, as Taurus, Gemini, &c.

To represent these stars, let there be a hole on each side of the spot that is marked for a star, about a quarter of an inch distant from each other, and let the extremities of two wires, neatly rounded, come through these holes, and be brought near together, exactly over the mark. These wires should be of different sizes, that they may the better represent the different magnitudes of the stars.

The other ends of the wires must be so disposed, that they may all receive a spark from the conductor at the same time, and the stars will then be all luminous at the same instant. These stars are not evanescent, like those made by the phosphorus, but will continue with
equal

equal splendor as long as the motion of the wheel is continued. After the same manner any cypher, or the outlines of a drawing, may be exhibited.

RECREATION XXIV.

The luminous characters.*

PROVIDE a board about four inches wide, as AB, (Plate IV. Fig. 1.) and of what length you please. On this board place ten or twelve rows of tin-foil, at about half an inch distance from each other, and that all communicate together. From these lines are to be cut out the characters you intend to represent; observing that the ends of the tin-foil where it is cut, should not be strait, but pointed as in the figure.

At the beginning of the tin-foil there must be a brass knob C, which being brought

* This is an invention of Mr. Henly, the author of the graduated electrometer described in the apparatus.

to the conductor, receives the electricity and conveys it to the tin-foil, over which it would run imperceptibly, were there no breaks in the lines, but being there interrupted, it jumps from one point to the other, making at the same time a lucid spot, by which the characters are formed, and will continue as long as the wheel is in motion. If at the same time the knob is applied to the conductor, the operator place his finger against the other end of the uppermost line of the tin-foil, and draw it slowly down, over the ends of the other lines, it will seem as if the characters were formed by the motion of his hand.

This experiment may be made by the discharge of a jar or phial, but it will then be of a short continuance. By this method also the constellations, or the outlines of a drawing, &c. may be represented.

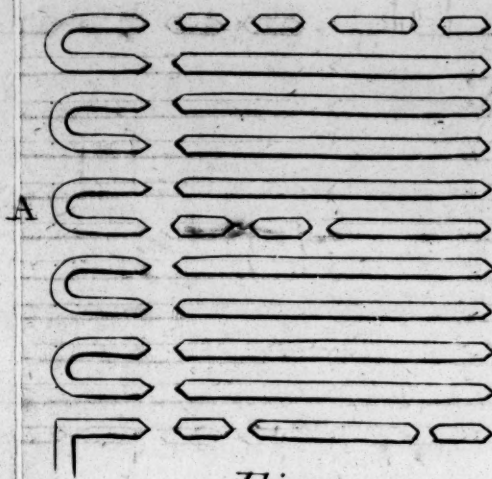


Fig. 2. p 34.

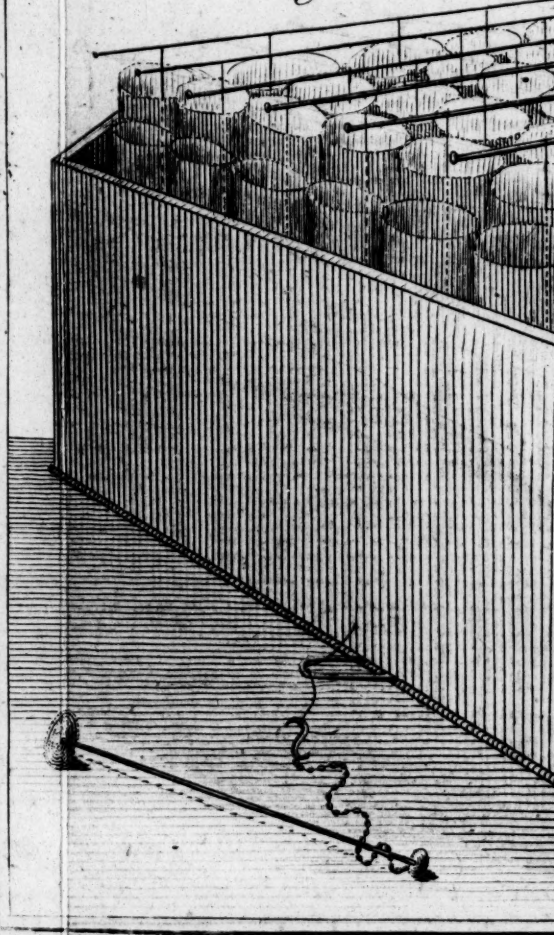
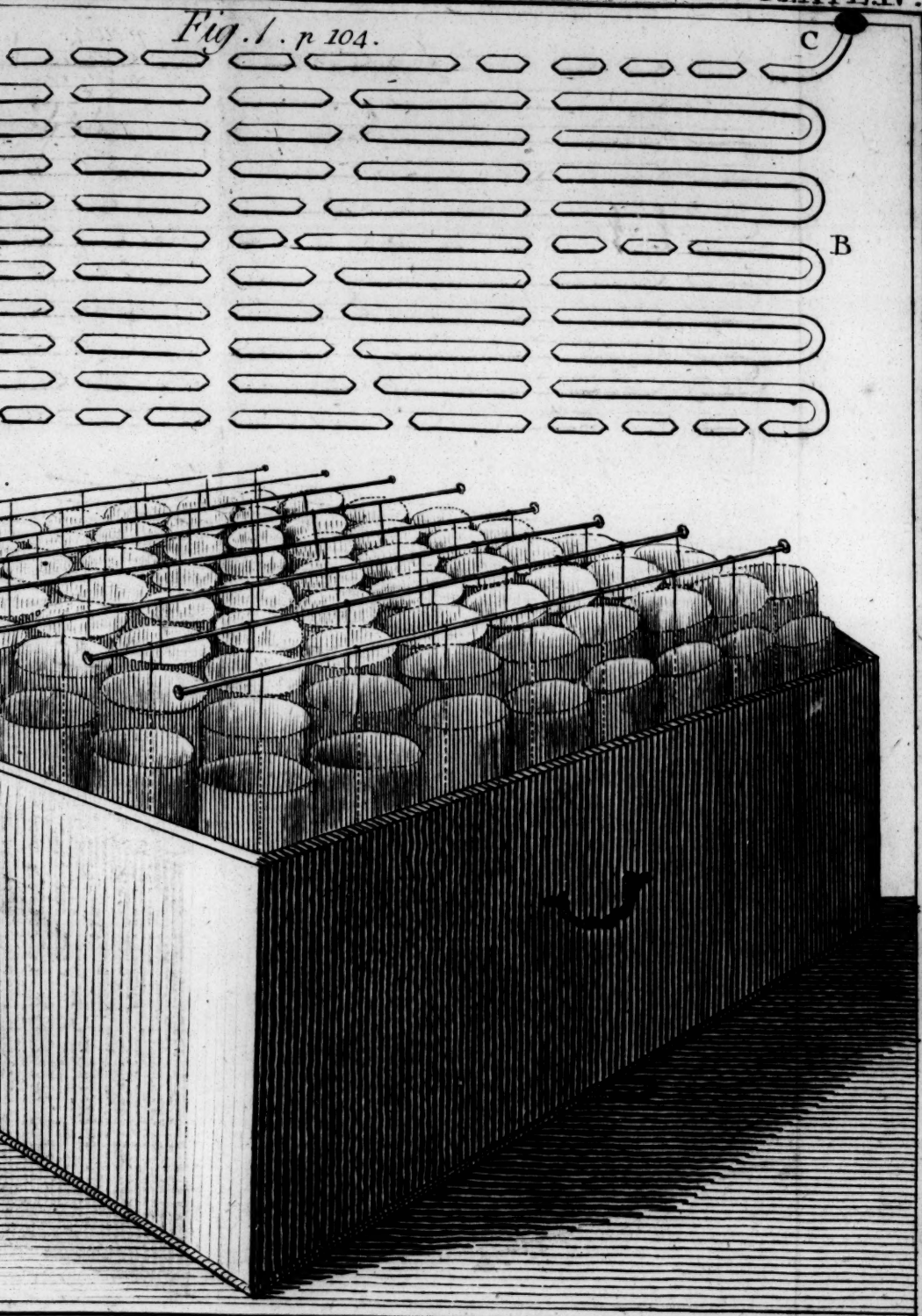
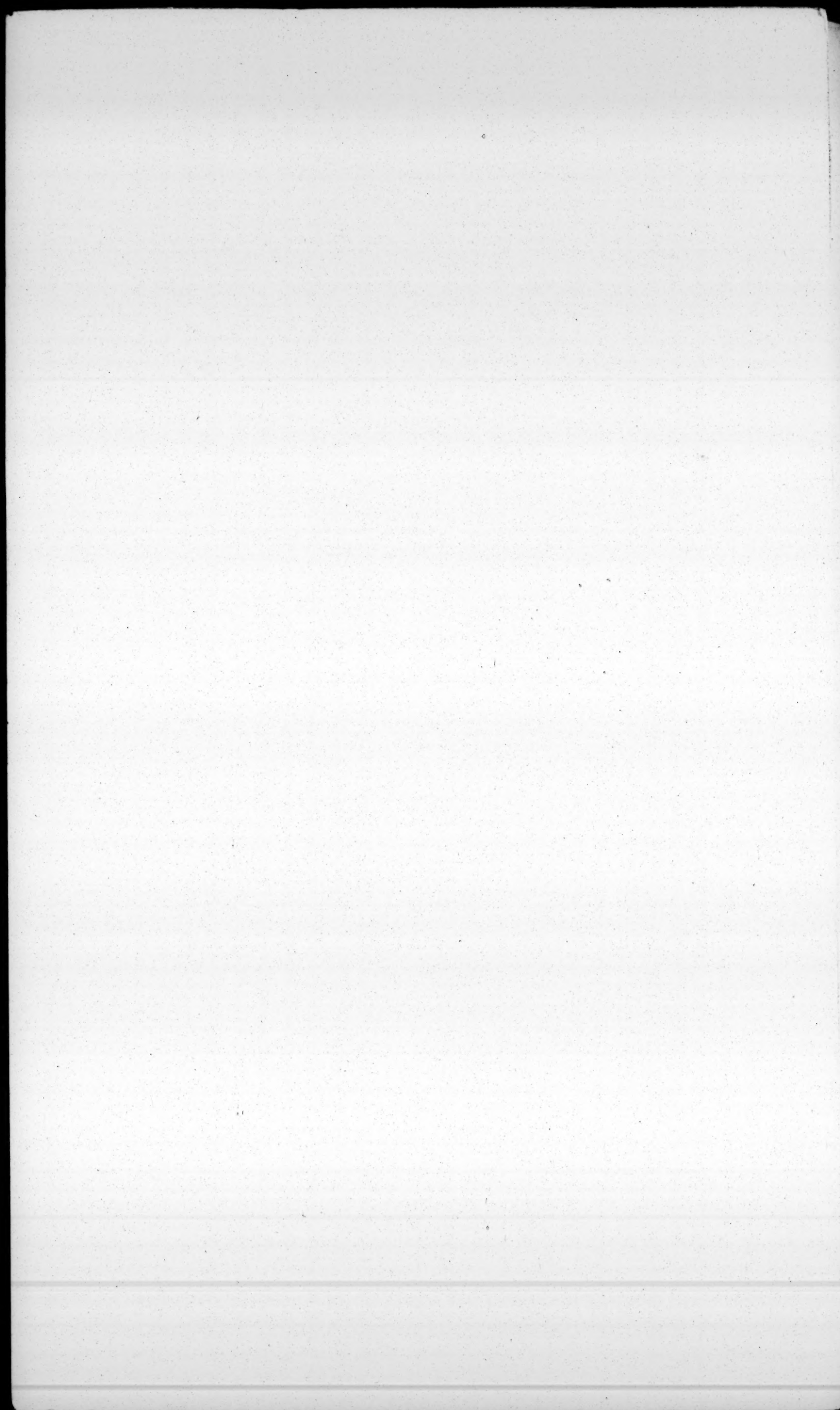


Fig. 1. p. 104.





RECREATION XXV.

Prismatic illumination *.

TAKE a glass vessel about a foot long and eight inches diameter, open at both ends; and let one of its ends be closed by a brass ferule, which is to constitute one of the centers on which it is to turn: the other end must be closed with a metal plate. In the center of the plate let there be a square stem, which is to be applied to the arbor of a lathe, by which the globe is to be turned round. On one side of this last plate must be fixed a cork, by means of which the glass is screwed upon the air-pump.

Upon rarefying the air within the glass about 500 times, and afterwards turning

* This experiment was first made by Mr. Smeaton, the inventor of the new air-pump.

the glass in the lathe, and rubbing in at the same time with the hand, a considerable quantity of lambent flame, variegated with all the colours of the rainbow, will appear within the glass under the hand. This light is perpetually changing colour under the hand, but in every other respect is pretty steady.

When a little air is let into the glass, the light appears more vivid, and in greater quantity, but is not so steady, for it will frequently break out into a kind of corruscation, like lightning, and fly all over the interior part of the glass. When a little more air is let in, the flashing is continual, and streams of bluish light seem to issue from under the hand, within the glass, in a thousand forms, with great rapidity, and appear like a cascade of fire. Sometimes it is seen to shoot out into the form of trees, moss, &c.

When

When more air is let in, the quantity of light is diminished, and the streams that compose the flashes narrower. The glass now requires greater velocity and harder friction. These circumstances will increase as still more air is let in, so that by the time the glass is one-third full of air, the corruscations quite vanish, and a much smaller quantity of light appears partly within, and partly without the glass. When all the air is let in, the light appears wholly without the glass, and much less in quantity than when the glass is only in part exhausted.

RECREATION XXVI.

The aurora borealis *.

MAKE a Torricellian vacuum in a glass tube, about three feet long, and seal it hermetically †: it will then be always ready for use. Let one end of this tube be held in the hand, and the other applied to the conductor, and immediately the whole tube will be illuminated, from one end: and when taken from the conductor will continue luminous, without interruption, for a considerable time, very often above a quarter of

* This is one of the inventions of that great benefactor to this science, Mr. Canton.

† The Torricellian vacuum is made by filling a tube with pure mercury, and then inverting it, in the same manner as in making a barometer; for as the mercury runs out, all the space above will be a true vacuum. A glass is hermetically sealed by holding the end of it in the flame of a candle, till it is ready to melt, and then twisting it together with a pair of pincers.

an hour. If after this, it be drawn through the hand either way, the light will be uncommonly intense, and, without the least interruption, from one hand to the other, even to its whole length. After this operation, which discharges it in a great measure, it will still flash at intervals, though it be held only at one extremity, and quite still; but if it be grasped by the other hand at the same time, in a different place, strong flashes of light will hardly ever fail to dart from one end to the other; and this will continue 24 hours, and perhaps much longer; without fresh excitation. Small and long glass tubes exhausted of air, and bent in many irregular crooks and angles, will when properly electrified, beautifully represent flashes of lightning.

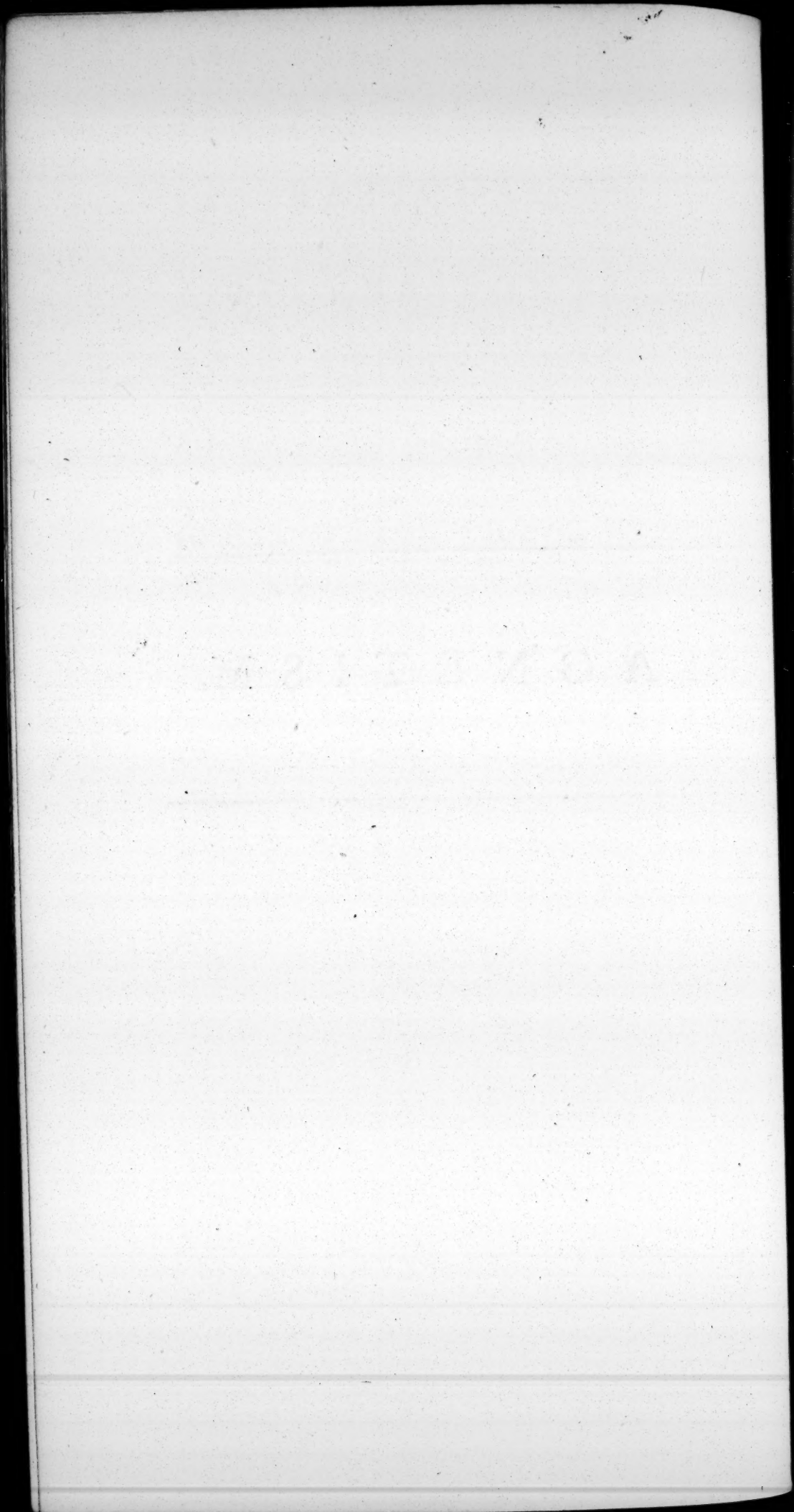
RECREATION XXVII.

The circulating lamps.

AFTER keeping the company thus long in the dark, it will be proper to illuminate the room before you dismiss them. In order to which introduce the circulating wheel mentioned in the 9th Recreation. To the upper axis of which let there be fixed a number of radii, made of baked wood, at the end of each of which must hang a small globular lamp, filled with spirits; and let that of each lamp be tinged with a different colour. The wheel, having previously acquired its greatest velocity, is to be placed on the table, and a chain, depending from the branch, is to dip into each lamp as it passes by; so that all of them will become illuminated in a very short time. These lamps will not only enlighten the room, but by their variegated colours, and continual revolution, afford a very pleasing phenomenon.

M A G-

M A G N E T I S M.



MAGNETISM.

DEFINITIONS.

1. **M**AGNETISM is the science that explains the several properties of the attractive and repellent powers in the magnet or loadstone.

2. The magnet is a rich, heavy, iron ore of a hard substance, a dusky grey colour, with some mixture of a reddish brown, and sparkling when broke.

3. The magnetic virtue is called the third species of attraction; gravity being the first, and electricity the second.

4. The two ends of a magnet, when it is properly formed, are called its poles; and when it is placed on a pivot, in just equilibrium, one end will turn toward the north, and is called its north pole, and the other end the south pole*.

* The poles of a magnet are found by holding a very fine short needle over it; for where the

5. When the two poles of a magnet are surrounded with plates of steel, it is said to be armed.

6. If the end of a small iron bar be rubbed against one of the poles of a magnet, it is said to be touched, and is then called an artificial magnet.

7. If such a magnet be supported on a pivot, it is called a magnetic needle; one end of it turning toward the north, and the other toward the south.

8. The difference between the position of the needle, and the exact points of north and south, is called its declination.

9. A needle which is touched, will incline toward the earth, and that is called its inclination or dipping.

poles are, the needle will stand upright, but nowhere else. The exterior parts are then to be filed or ground off, and the two extremities which contain the poles, to be made quite smooth.

RECREATIONS. 115

A P H O R I S M S.

1. The magnetic attraction is produced by effluvia emitted by the magnet, and passing from one pole to the other*.

2. One pole of a magnet will attract iron, and the other repel it, but no other body †.

* The direction of the magnetic effluvia is shown by the following experiment. Let AB, CD, (Plate VI. Fig. 1.) be the poles of a magnet. Round every side lightly strew steel filings, on a sheet of white paper; the particles of the filings will be so affected by the effluvia of the stone, as to show the course they take every way. In the middle of each pole, between AB and CD, they appear to proceed in lines nearly straight: toward the ends they are more and more curved, till at last the lines from both sides, coinciding with each other, form numberless curves round the stone, which are nearly of a circular figure, as in the plate. This experiment seems to shew that the magnetic effluvia issuing from one pole, circulates to the other.

† The property of the magnet to attract iron has been known many ages; but those of its polar direction, and of its communicating that property to iron, was not discovered till the 14th century.

3. The magnet attracts iron as well in vacuo, as in the air.

4. The magnetic attraction will be continued through several pieces of iron placed contiguous to each other.

5. The magnetic effluvia pervades all bodies.

6. The magnetic attraction extends to a considerable distance*.

7. The north pole of one magnet will attract the south pole of another: and the similar poles will repel each other†.

* The learned Muschenbroek made a number of experiments, with great care and assiduity, to determine the extent and progress of the magnetic attraction, but was never able to discover any regular proportion between the force and distance; but merely that the force increased as the iron approached the magnet. Nor does there seem to be any prospect of establishing the proportion of attraction to the distance, till a method is found, if it can be found, of separating the attracting from the repelling parts. A needle has been known to be attracted by an iron bar at the distance of eight or ten feet.

† If a magnet be gently cut through the middle of its axis, each piece becomes a complete magnet;
for

8. The end of a needle touched by the north pole of a magnet will turn south, and that touched by the south pole will turn north.

9. The declination of the magnetic needle is different in different parts of the earth, and in the same part at different times*.

10. The inclination of the needle is not

for the parts that were contiguous become poles, and even opposite poles. So that the end of each piece may become a north or south pole according as the section is made nearest to the north or south pole of the large magnet. Upon cutting a magnet longitudinally, there will be four poles, in the same position as before the cutting. Sometimes a strong stroke with a hammer will bring all the magnetic power from one end of a needle to the other; sometimes make it more strong where it was before, and at other times totally destroy it.

* The declination of the needle at London, in the year 1580, was 11 degrees 15 minutes east. In the year 1657, there was no declination, that is, the needle stood exactly north and south. At present, the declination is more than 22 degrees westward.

always the same in different places, nor in the same place at different times*.

11. The strength of natural magnets differs in those of different magnitudes, but not in proportion to their magnitudes†.

* The inclination of the needle when it was first observed, in the year 1576, was found to be 71 degrees 50 minutes: at present it is between 74 and 75 degrees.

To prevent the dipping of the needle in the common compass, the end that is not touched is made something heavier, by which it is kept in equilibrio. Under the equator the needle has no inclination, being equally attracted by the two poles of the earth.

† The smallest magnets have generally the greatest power, in proportion to their bulk. A large magnet will seldom take up more than three or four times its own weight; whereas a small one will frequently take up more than ten times its weight. A magnet that weighs scarce three grains, and that a gentleman wears in his ring, will take up 746 grains, or 250 times its own weight. A magnetic bar made by Mr. Canton, according to the method we shall hereafter describe, and that weighed 10 ounces 12 pennyweights, took up something more than 79 ounces; and a flat semicircular steel magnet that weighed

12. The strength of a natural magnet is considerably increased by its being armed*.

weighed an ounce and 13 pennyweights, lifted an iron wedge of 90 ounces.

* There are various ways of arming magnets; the most eligible seems to be that of placing two pieces of steel against the two poles, so that they may come down below the bottom of the stone, and binding them on with one or more pieces of brass; the two ends of the steel pieces then become the poles of the magnet. To determine the quantity of steel to be applied, try the magnet with several steel bars, and the greatest weight it takes up, with a bar on, is to be the weight of its armour.

Though an armed magnet have a great degree of force, it may be easily counteracted. If an oblong piece of iron be suspended by one of its poles, and the pole of a different denomination of a weaker and unarmed magnet be placed under the iron, it will quit the first magnet and adhere to the other. In like manner when a needle hangs by its point to a magnet, if a common bar of iron be applied to the head of the needle, it will directly quit the magnet and adhere to the bar: but if it hang by its head to the magnet, neither the iron, nor a weak magnet, will disengage it. Though

13. Iron acquires a magnetic power by being continually rubbed in the same direction*.

14. Iron bars become magnetic by standing a long time nearly upright†.

the pole of an armed magnet have great power, yet if an iron bar of great length be placed under it, the magnet will not appear to have any force whatever.

If a magnet, by lying a long time unused, have lost part of its power, it may sometimes be recovered. An armed magnet that weighed 14 ounces and a half, and would take up 16 times its own weight, by lying by some years lost one-fourth part of its power. But as much weight being applied to it, as it would then take up, and being suffered to hang to it some weeks, it would then take up an additional quantity; and the quantity being continually increased, at different periods, for the space of two years, it would then take up more than 20 pounds; whereas, before its virtue was impaired, it would not take up 15.

* From hence files, augurs, and such like tools, have always some magnetic power.

† Therefore pokers, tongs, and other irons, that always stand with the same end downward, are constantly magnetic; and the continual friction they receive, in keeping them clean, contributes

15. The magnetic virtue may be communicated by electricity*.

16. A strong blow at the end of a magnetic bar will give it a magnetic power†.

17. Fire totally destroys the power of magnets, as well natural as artificial.

Butes much to this. Some bars acquire several magnetic poles, alternately North and South.

* When the electric shock is very strong it will give a polarity to needles; and sometimes it will reverse their poles.

† If such a bar, or a pair of pincers, be struck hard, or thrown forcibly against a stone floor, they will manifestly attract a small needle that floats upon the surface of the water in a glass.

METHOD OF MAKING ARTIFICIAL
MAGNETS*.

PROCURE a dozen bars; fix of soft steel, each three inches long, one quarter of an inch broad, and one twentieth of an inch thick, with two pieces of iron, each half the length of one of the bars, but of the same breadth and thickness; and fix of hard steel, each five inches and a half long, half an inch broad, and three twentieths of an inch thick, with two pieces of iron of one half the length, but the same breadth and thickness as one of the hard bars; and let all the bars be marked with a line quite round them at one end.

Then take an iron poker and tongs (Plate V. Fig. 1.) the larger they are and

* There are various methods of making these magnets: this method is taken from the 47th volume of the Philosophical Transactions, and was invented by the late Mr. Canton; to whom the learned world is indebted for many useful discoveries and improvements in magnetism, as well as electricity.

the longer they have been used, the better; and fixing the poker upright between the knees, hold to it near the top, one of the soft bars, having its marked end downward, by a piece of sewing silk, which must be pulled tight with the left hand, that the bar may not slide: then grasping the tongs with the right hand, a little below the middle, and holding them nearly in a vertical position, let the bar be stroked, by the lower end, from the bottom to the top, about ten times on each side, which will give it a magnetic power sufficient to lift a small key at the marked end; which end, if the bar was suspended on a point, would turn toward the north, and is therefore called the north pole, and the unmarked end is, for the same reason, called the south pole of the bar.

Four of the soft bars being impregnated after this manner, lay the other two (Fig. 2.) parallel to each other, at the distance of about a quarter of an inch,
between

between the two pieces of iron belonging to them, a north and a south pole against each piece of iron : then take two of the four bars already made magnetical, and place them together, so as to make a double bar in thickness, the north pole of one even with the south pole of the other ; and the remaining two being put to these in such a manner as to have two north and two south poles together, separate the north from the south poles at one end, by a large pin, and place them perpendicularly with that end downward, on the middle of one of the parallel bars, the two north poles towards its south, and the two south poles towards its north end : slide them backward and forward, three or four times, the whole length of the bar ; and removing them from the middle of this, place them on the middle of the other bar as before directed, and go over that in the same manner : then turn both the bars the other side upwards, and repeat the former operation : this being done, take the

the two from between the pieces of iron, and placing the outermost of the touching bars in their room, let the other two be the outermost of the four to touch these with: and this process being repeated till each pair of bars have been touched three or four times over, which will give them a considerable magnetic power, put the half dozen together after the manner of the four, Fig. 3, and touch with them two pair of hard bars, placed between their irons, at the distance of about half an inch from each other: then lay the soft bars aside, and with the four hard ones let the other two be impregnated, Fig. 4, holding the touching bars apart, at the lower end, near two tenths of an inch, to which distance let them be separated, after they are set on the parallel bar, and brought together again before they are taken off.

This being observed, proceed according to the method described above till each
pair

pair has been touched two or three times over. But as this vertical way of touching a bar will not give it quite so much of the magnetic virtue as it will receive, let each pair be now touched once or twice over, in their parallel position between the irons, Fig. 5, with two of the bars held horizontally, or nearly so; by drawing at the same time the north of one from the middle over the south end, and the south of the other from the middle over the north end of a parallel bar: then bringing them to the middle again, without touching the parallel bar, give three or four of these horizontal strokes to each side. The horizontal touch, after the vertical, will make the bars as strong as they can possibly be made: as appears by their not receiving any additional strength, when the vertical touch is given by a great number, and the horizontal, by bars of a superior magnetic power. This whole process may be gone through in about half an hour; and
each

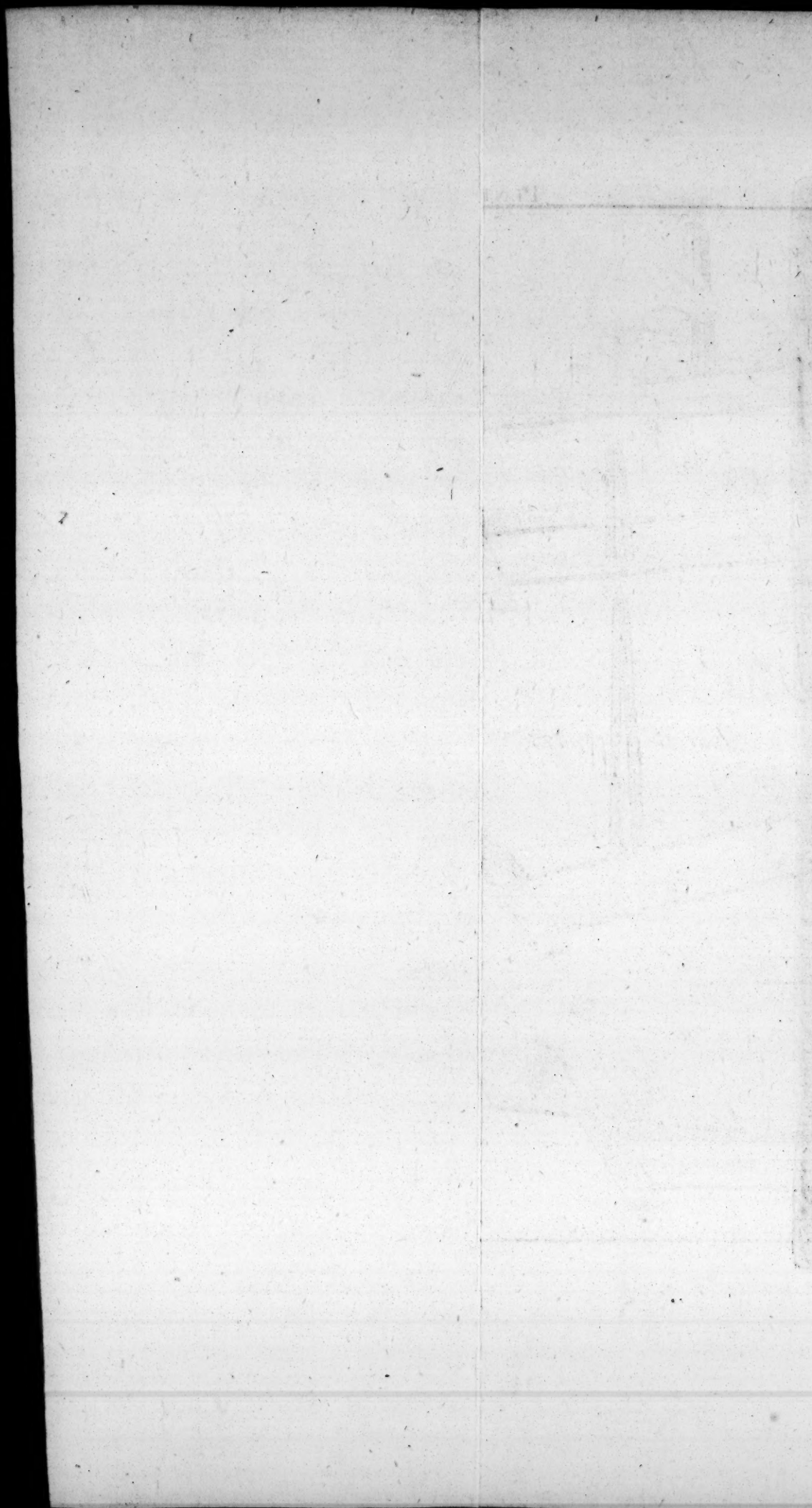


Fig. 2.
p. 123.

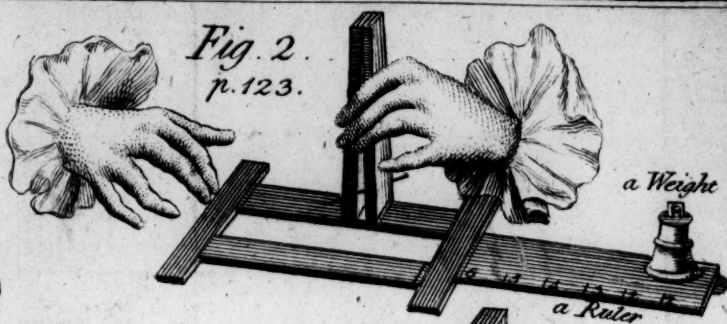


Fig. 1. p. 122.



Fig. 3.
p. 125.

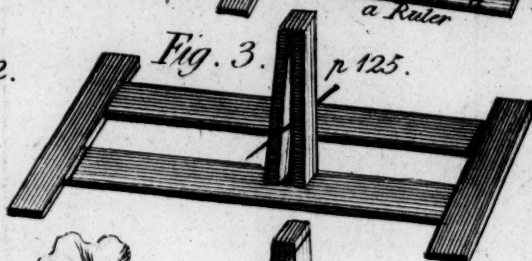


Fig. 4.
p. 125.

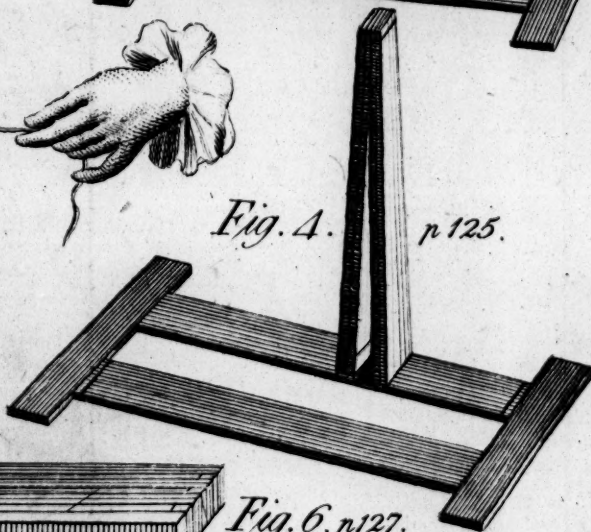


Fig. 6. p. 127.

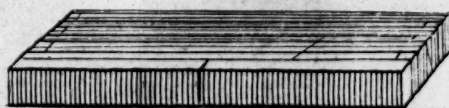
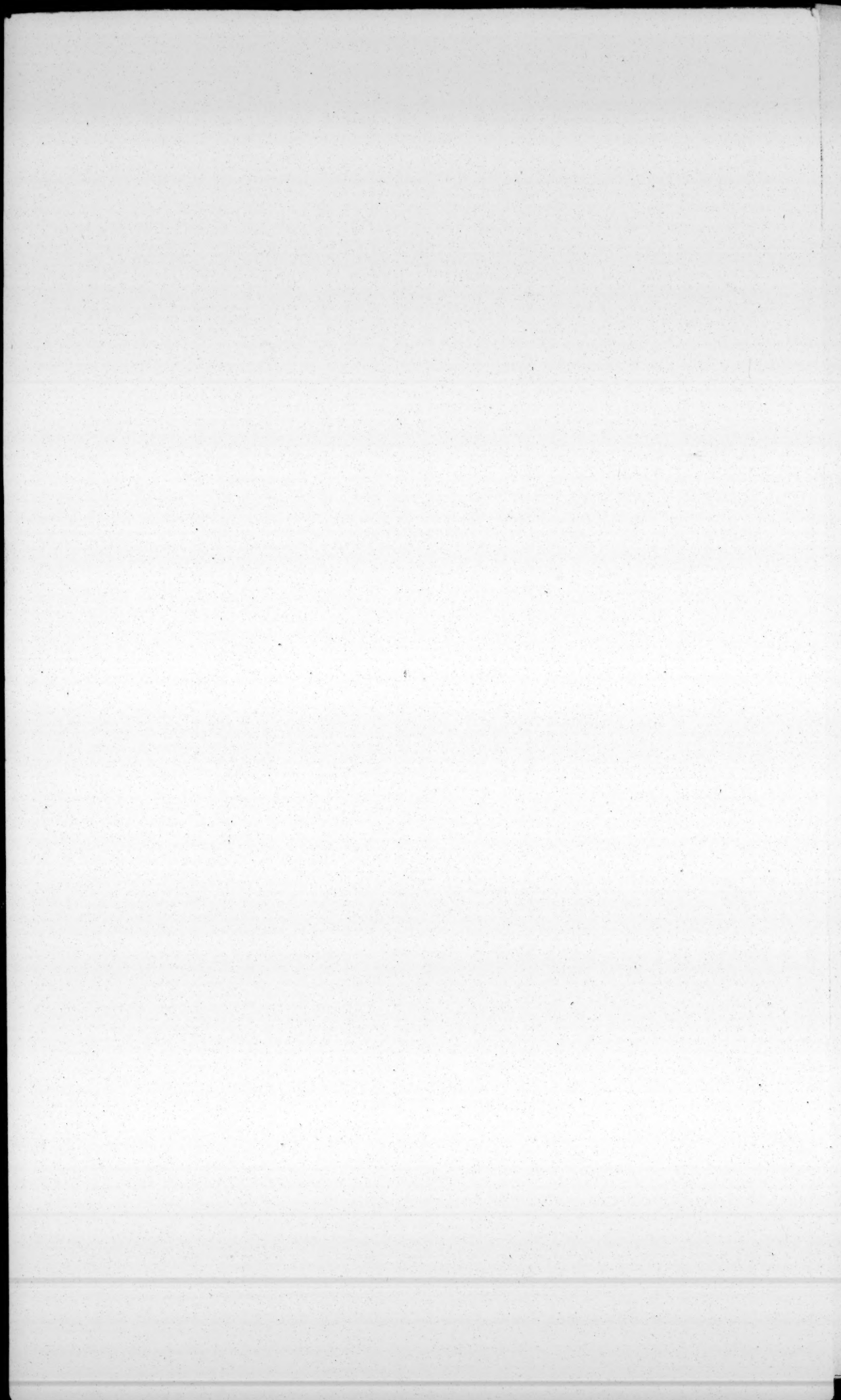


Fig. 5. p. 126.





each of the large bars, if well hardened, may be made to lift 28 Troy ounces; and sometimes more. And when these bars are thus impregnated, they will give to an hard bar of the same size, its full virtue in less than two minutes; and therefore will answer all the purposes of magnetism in navigation and experimental philosophy, much better than the loadstone, which is well known not to have sufficient power to impregnate hard bars. The half dozen being put into a case, Fig. 6, in such manner, as that two poles of the same denomination may not be together, and their irons with them as one bar, they will retain the virtue they have received. But if their power should, by making experiments, be ever so far impaired, it may be restored without any foreign assistance in a few minutes. And if, out of curiosity, a much larger set of bars should be required, these will communicate to them a sufficient power to
proceed

proceed with, and they may in a short time, by the same method, be brought to their full strength.

THE MAGNETIC PERSPECTIVE GLASS.

PROVIDE an ivory tube, about two inches and a half long, and of the form expressed in plate VI. Fig. 2. The sides of this tube must be thin enough to admit a considerable quantity of light. It is to open at one end with a screw: at that end there must be placed an eye glass A, Fig. 3, of about two inches focus, and at the other end, any glass you please.

Have a small magnetic needle, like that placed on a compass. It must be strongly touched, and so placed at the bottom of the tube that it may turn freely round. It is to be fixed on the center of a small ivory circle C, of the thickness of a counter, which is placed on the object glass D, and painted black on the side
next

next it. This circle must be kept fast by a circular rim of pasteboard, that the needle may not rise off its pivot, after the same manner as in the compass. This tube will thus become a compass sufficiently transparent to show the motions of the needle. The eye-glass serves more clearly to distinguish the direction of the needle; and the glass at the other end, merely to give the tube the appearance of a common perspective.

It will appear by aphorism 8, that the needle in this tube, when placed over, and at a small distance from, a magnet, or any machine in which it is contained, will necessarily place itself in a position directed by that magnet, and consequently show where the north and south pole of it is placed. The north end of the needle constantly pointing to the south end of the magnet.

This effect will take place though the magnet be inclosed in a case of wood, or

even metal, as the magnetic effluvia penetrates all bodies. You must observe, however, that the attracting magnet must not be very far distant from the needle, especially if it be small, as in that case its influence extends but to a short distance.

This tube may be differently constructed by placing the needle in a perpendicular direction, on a small axis of iron, on which it must turn quite freely, between two small plates of brass placed on each side the tube; the two ends of the needle should be in exact equilibrium. The north and south ends of this needle will, in like manner, be attracted by the south and north ends of the magnetic bar. The former construction, however, appears preferable, as it is more easily excited, and the situation of the needle much more easily distinguished.

THE MAGNETIC WAND.

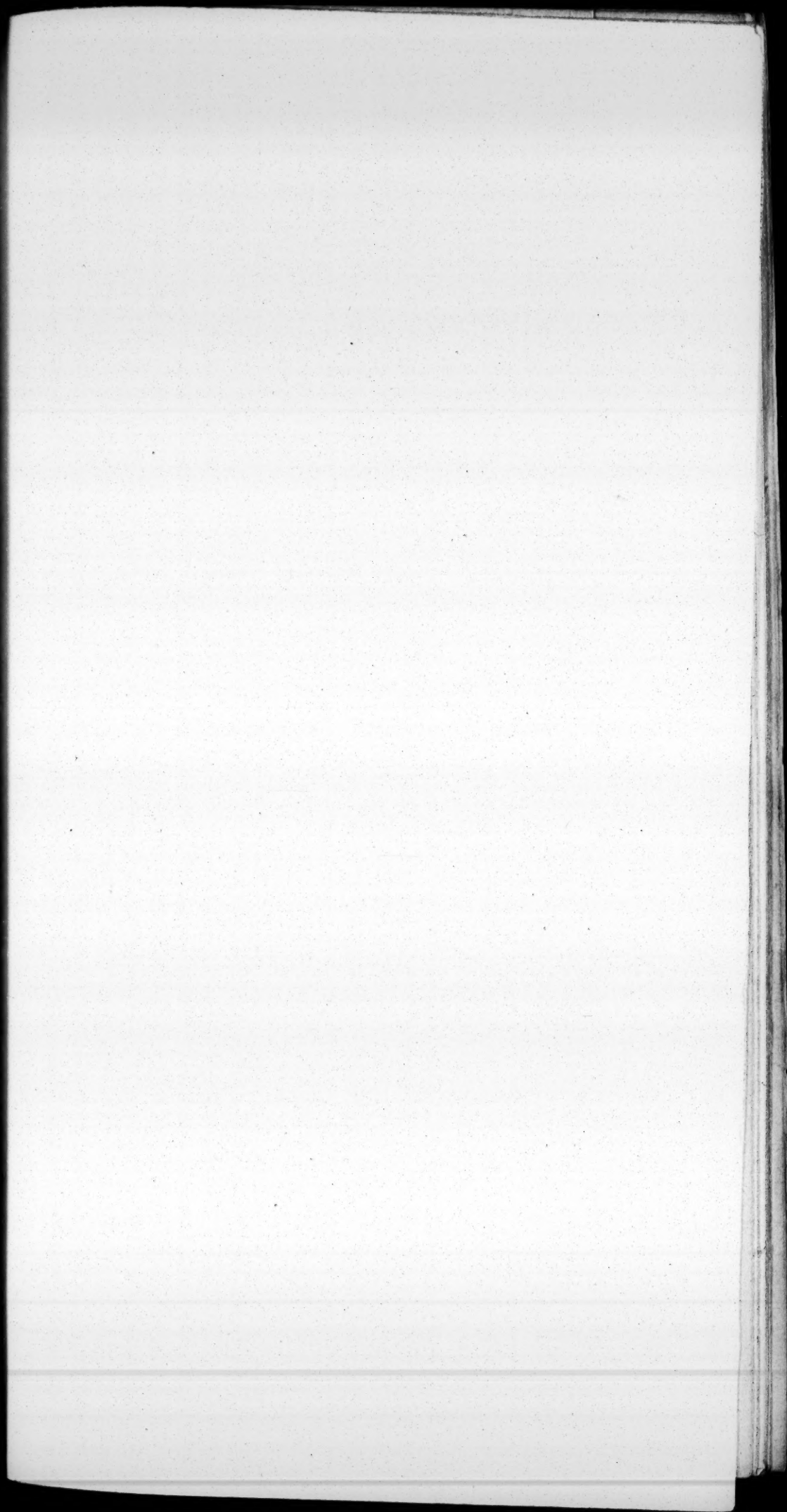
PROCURE a round stick of ebony, or other wood, of about eight or ten inches long, and about half an inch thick, Let there be a hole bored through the length of it, of about two or three-tenths of an inch in diameter (see Pl. VI. Fig. 4.) Provide a small steel rod C, and let it be very strongly impregnated by a good magnet. Place this rod in the hollow of the wand, and close it at each extremity, by two small ends of ivory A and B, that screw on, and are differently formed, that you may the more easily remember the poles of the magnetic bar.

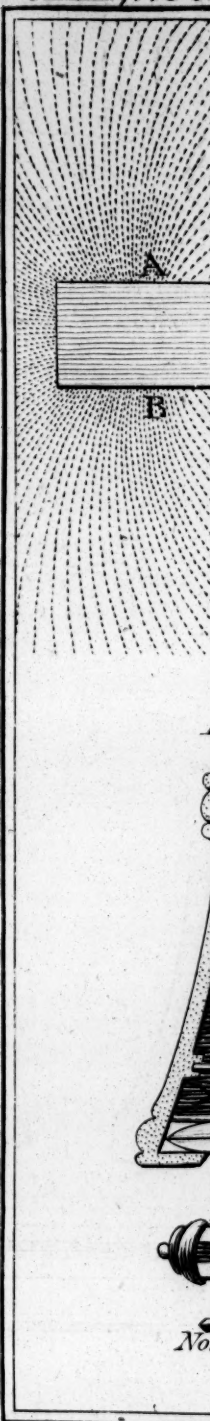
When you present the north pole of this wand to the south pole of a magnetic needle, suspended freely on a pivot, or to a light body swimming on the surface of water, or any other fluid, and in which you have placed a magnetic bar, that body

K 2
will

will then approach the wand, and present that side which contains the south end of the bar. On the contrary, if you present the north or south end of the wand to the north or south end of the needle, or of the bar, they will recede from it.

Observe, that after the needle or the floating bar has retired from the wand, it will present the other pole to it; therefore as soon as the needle retires, you must withdraw the wand, or keep it constantly presented to the pole of the same name. This wand is of use but in very few experiments. To give it more force it may be armed with iron, after the manner explained in the aphorisms.





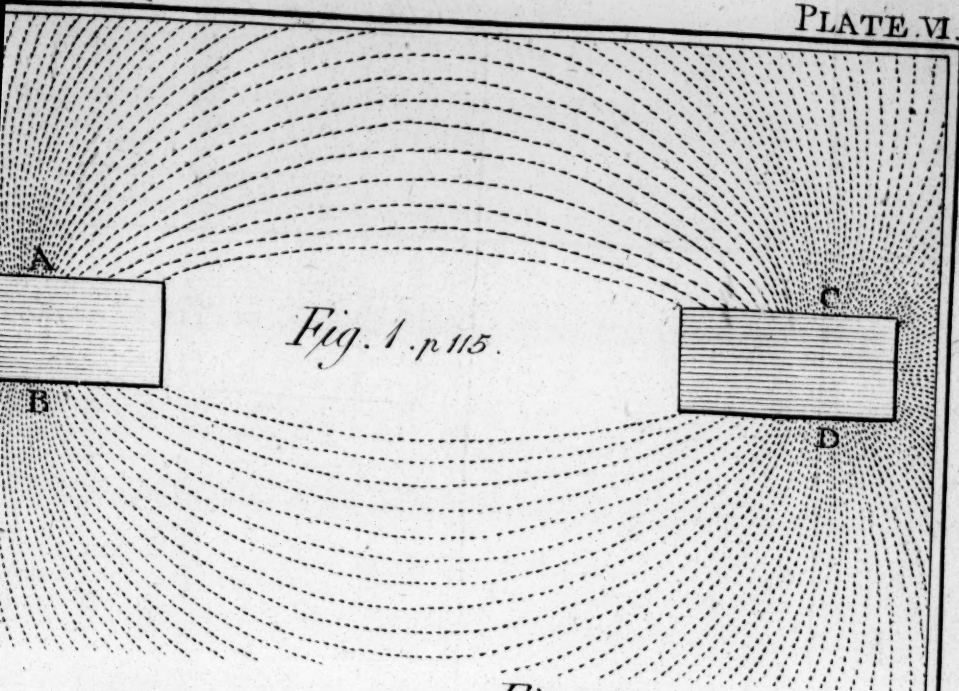


Fig. 3. p 128.

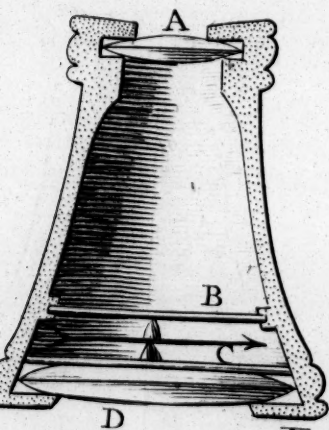


Fig. 2. p 128.

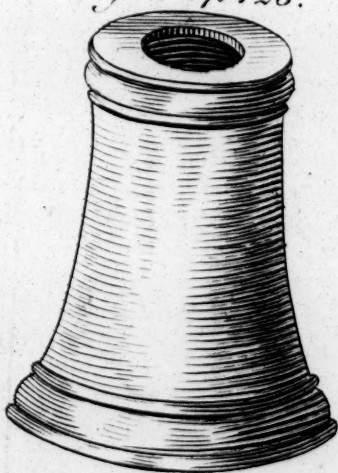
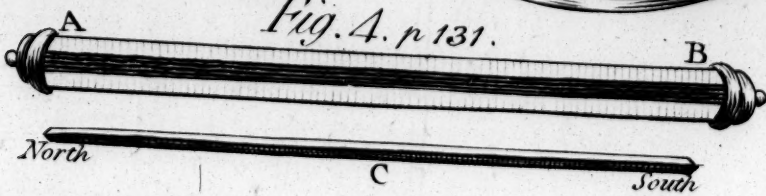
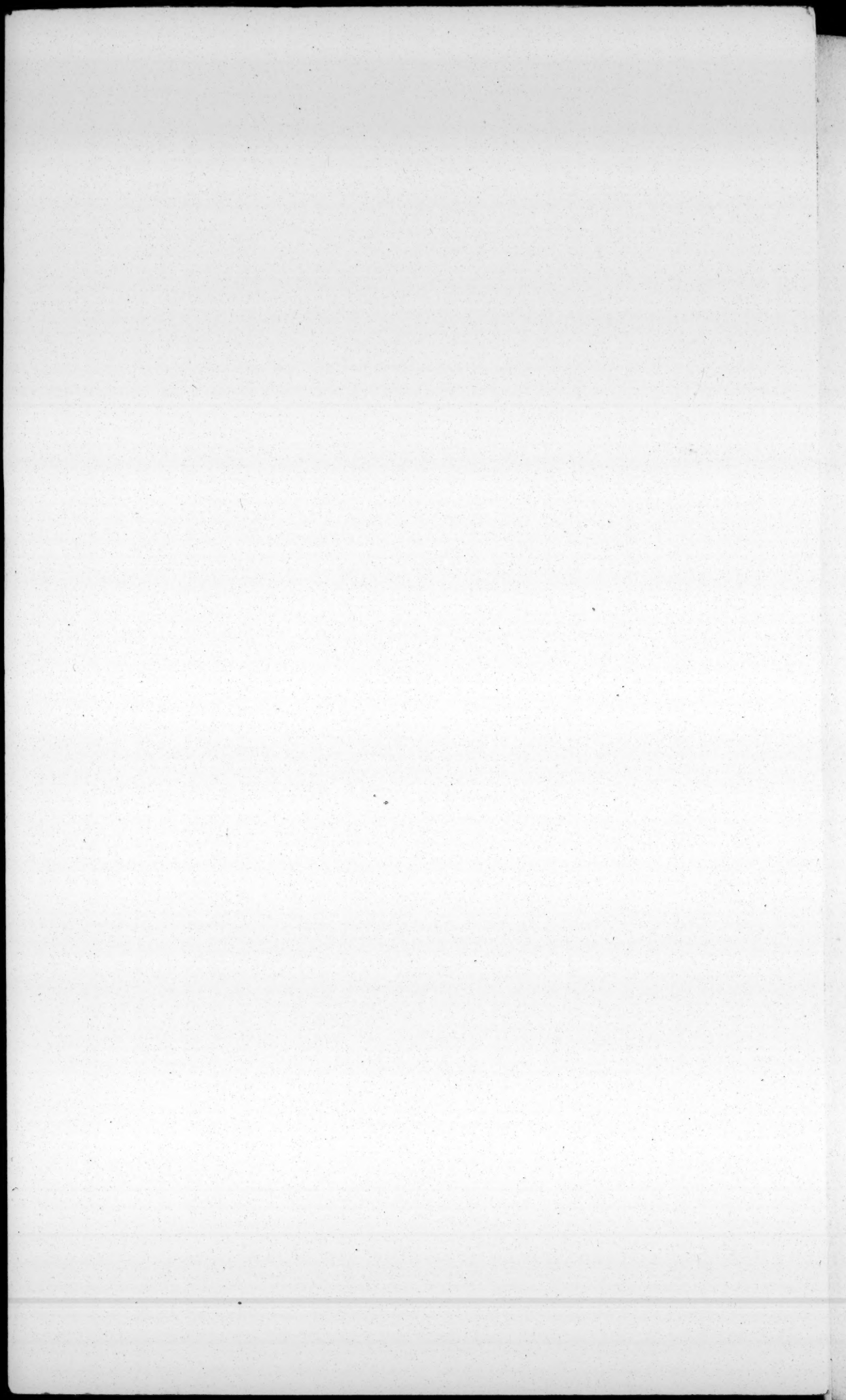


Fig. 4. p 131.





RECREATION XXVIII.

The communicative crown.

TAKE a crown piece, and bore a hole in the side of it; in which place a piece of wire, or a large needle well polished, and strongly touched with a magnet. Then close the hole with a small piece of pewter, that it may not be perceived. Now the needle in the magnetic perspective before described, when it is brought near to this piece of money, will fix itself in a direction correspondent to the wire or needle in that piece.

Desire any person to lend you a crown piece, which you dextrously change for one that you have prepared as above. Then give the latter piece to another person, and leave him at liberty either to put it privately in a snuff-box, or not; he is then to place the box on a table, and you are to tell him, by means of your glass, if

the crown is or is not in the box. Then bringing your perspective close to the box, you will know, by the motion of the needle, whether it be there or not; for as the needle in the perspective will always keep to the north of itself, if you don't perceive it has any motion, you conclude the crown is not in the box. It may happen, however, that the wire in the crown may be placed to the north, in which case you will be deceived. Therefore to be sure of success, when you find the needle in the perspective remain stationary, you may make some pretence to desire the person to move the box into another position, by which you will certainly know if the crown piece be there or not.

You must remember that the needle in the perspective must here be very sensible, as the wire in the crown cannot possibly have any great attractive force.

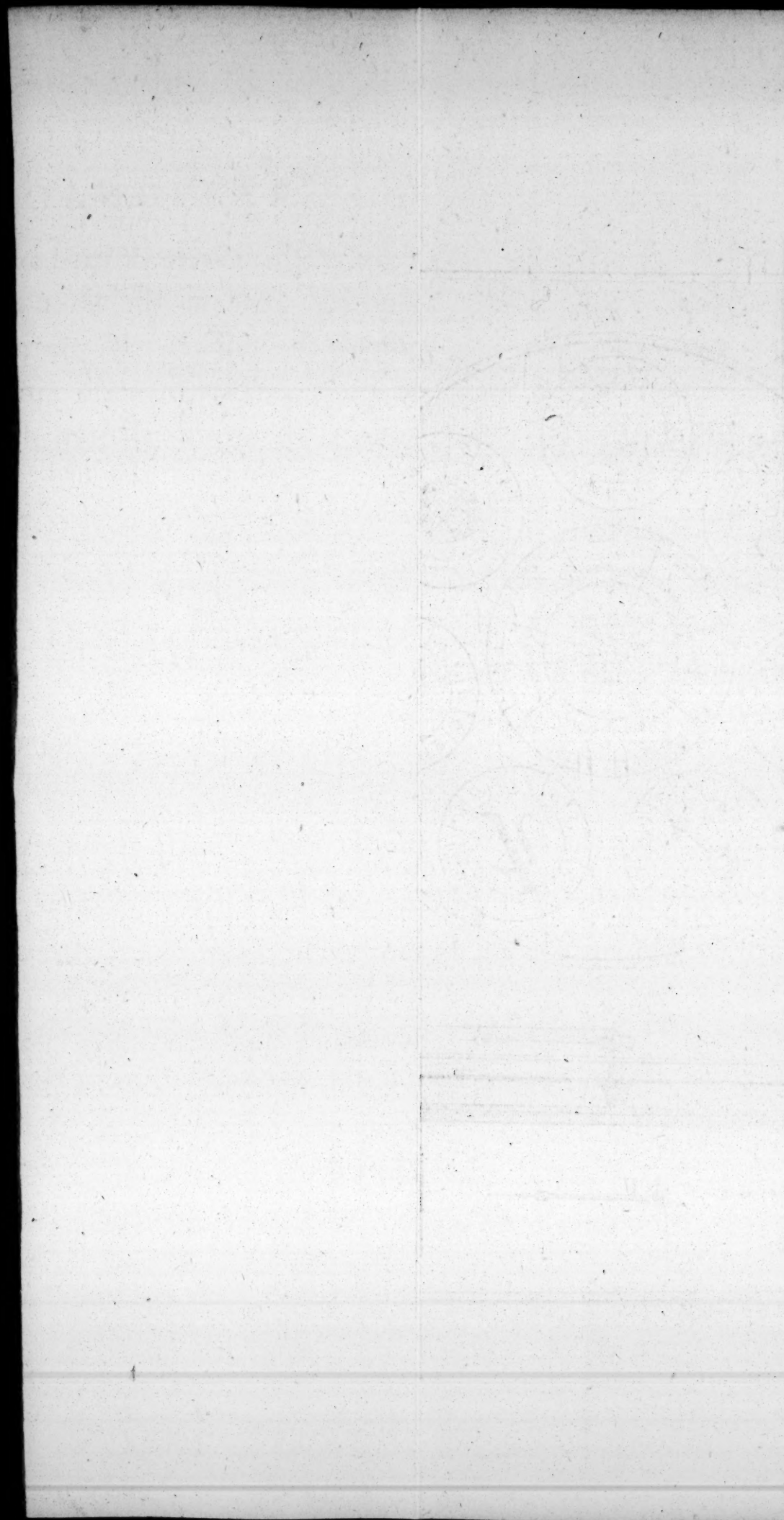


Fig. 1. p. 180.

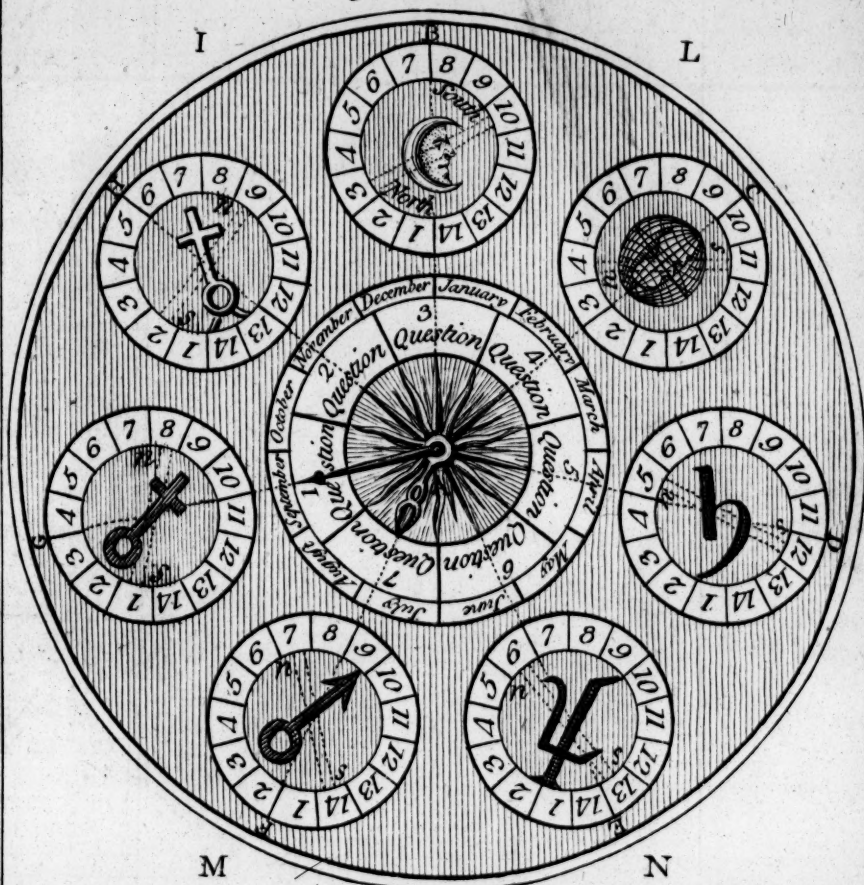
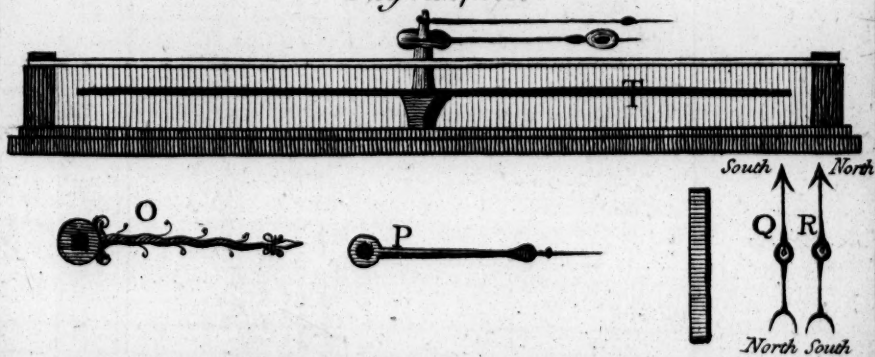
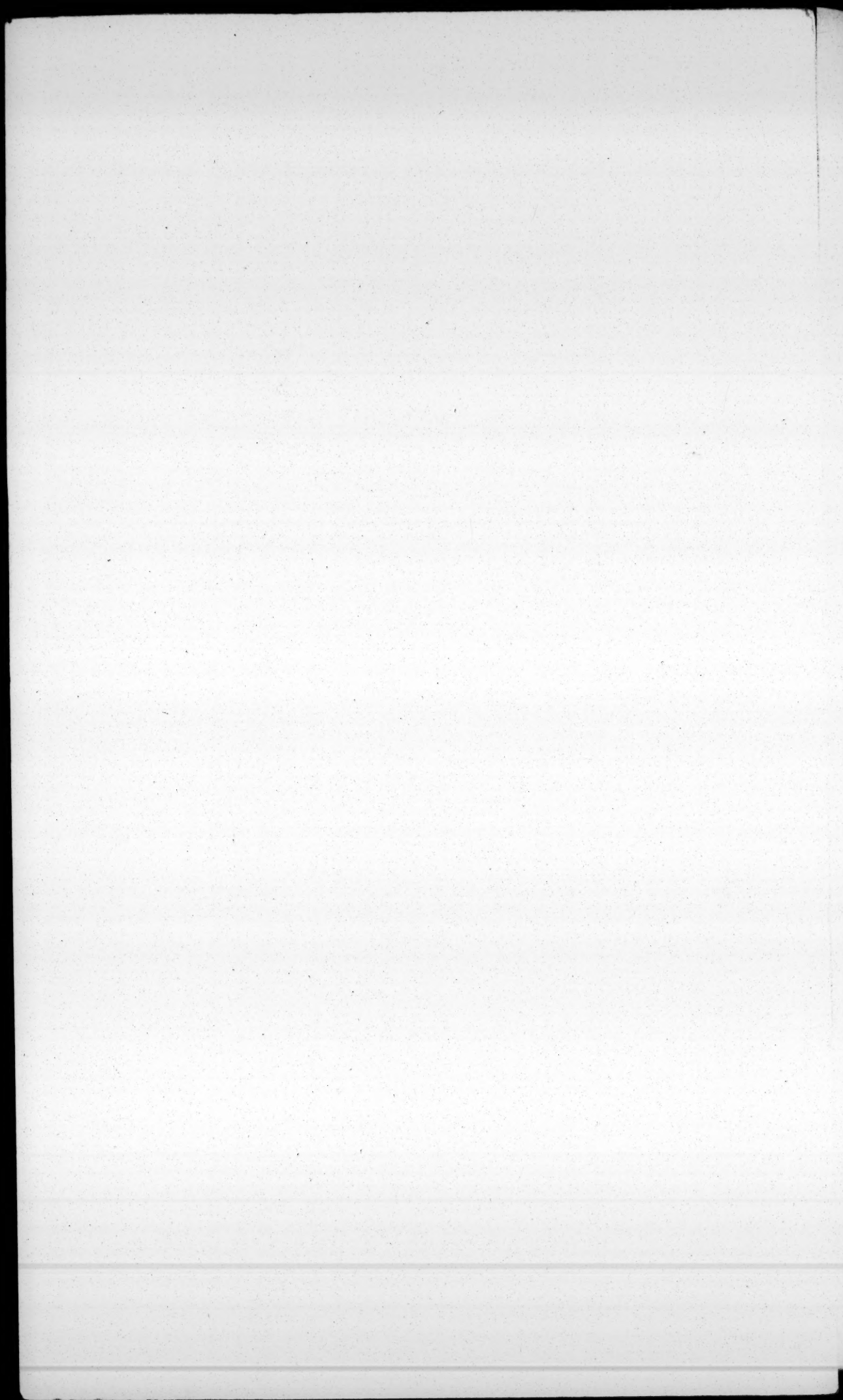


Fig. 2. p. 181.





RECREATION XXIX.

The magnetic table.

UNDER the top of a common table place a magnet that turns on a pivot, and fix a board under it, that nothing may appear. There may also be a drawer under the table, which you pull out to show that there is nothing concealed. At one end of the table there must be a pin that communicates with the magnet, and by which it may be placed in different positions: this pin must be so placed as not to be visible by the spectators. Strew some steel filings, or very small nails, over that part of the table where the magnet is. Then ask any one to lend you a knife, or a key, which will then attract part of the nails or filings, in the same manner as the iron attracts the needle, in the note to the twelfth aphorism. Then placing your hand, in a careless manner,

on the pin at the end of the table, you alter the position of the magnet ; and giving the key to any person, you desire him to make the experiment, which he will then not be able to perform. You then give the key to another person, at the same time placing the magnet, by means of the pin, in the first position, when that person will immediately perform the experiment.

RECREATION XXX.

The mysterious watch.

YOU desire any person to lend you his watch, and ask him if he thinks it will or will not go, when it is laid on the table. If he say it will, you place it over the end of the magnet, and it will presently stop*. You then mark with chalk, or a pencil, the precise point where you placed

* To perform this experiment you must use a strong magnetic bar, and the balance of the watch must not be of brass, but steel.

the watch, and moving the position of the magnet, as in the last Recreation, you give the watch to another person, and desire him to make the experiment, in which he not succeeding, you give it to a third person, at the same time replacing the magnet, and he will immediately perform the experiment.

RECREATION XXXI.

The bouquets.

IN a box of light wood, that shuts with hinges, and is about nine or ten inches long, five or six wide, and one inch thick, as ABCD (Pl. VII. Fig. 1.) fix a small vase, that has a hole in one side, through which is to pass the end of a bouquet of artificial flowers; of which you are to have two, as F and G. The two principal stalks of these bouquets are to be made of steel, that has been strongly touched; and you are to observe that the north pole of one of these bouquets is to be placed

placed in the vase, and the other is to be at the top of the flower. Both these wires, as well as all the others that compose the flowers, are to be covered with silk.

You present one of these bouquets to any person, and give him the choice either of placing it privately in the vase or not. Then, shutting the box, he is to give it you. When applying the magnetic perspective to it, you discover, by the motion of the needle, whether it be there or not; for if it be not there, the needle will not fix itself to either end of the box.

You then present both the flowers, and give him the choice of placing either of them, in like manner in the box; and by applying the perspective as before, you discover, by the fixing of the needle, which of the bouquets is there placed. You may yet farther diversify this Recreation by having three flowers, of which
one

one must not be impregnated; and give the person the choice of placing either of them in the box; but in this case he must put in one of them.

You must observe that the needle in the perspective, in making this experiment, must be very sensible: it will be proper to try its force on the stalk of the bouquet before the flowers are placed on it.

RECREATION XXXII.

The magnetic dial.

PROVIDE a circle of wood or ivory, of about five or six inches diameter, as Pl. VII. Fig. 2, which must turn quite free on the stand B, in the circular border A: on the circular must be placed the dial of pasteboard C, whose circumference is to be divided into twelve equal parts, in which must be inscribed the numbers from one to twelve, as on a common dial. There must be a small
 9 groove

groove in the circular frame A, to receive the pasteboard circle; and observe that the dial must be made to turn so free, that it may go round without moving the circular border in which it is placed.

Between the pasteboard circle and the bottom of the frame, place a small artificial magnet E, Fig. 3, that has a hole in its middle, or a small protuberance. On the outside of the frame place a small pin P, which serves to show where the magnetic needle I, that is placed on a pivot at the center of the dial, is to stop. This needle must turn quite free on its pivot, and its two sides should be in exact equilibrio.

Then provide a small bag, that has five or six divisions, like a lady's work-bag, but smaller. In one of these divisions put small square pieces of pasteboard, on which are wrote the numbers from one to twelve; and if you please you may put several of each number. In each of the
other

other divisions you must put twelve or more like pieces, observing that all the pieces in each division must be marked with the same number.

Now the needle being placed upon its pivot, and turned quickly about, it will necessarily stop at that point where the north end of the magnetic bar is placed: and which you previously know by the situation of the small pin in the circular border.

You therefore present to any person that division of the bag which contains the several pieces on which is wrote the number opposite to the north end of the bar, and tell him to draw any one of them he pleases. Then placing the needle on the pivot, you turn it quickly about, and it will necessarily stop, as we have already said, at that particular number.

Another Recreation may be made with the same dial, by desiring two persons to
draw

draw, each of them, one number out of two different divisions of the bag, and if their numbers, when added together, exceed twelve, the needle or index will stop at the number they exceed it: but if they do not amount to twelve, the index will stop at the sum of those two numbers. In order to perform this Recreation you must place the pin against the number five, if the two numbers to be drawn from the bag be ten and seven: or against nine, if they be seven and two.

If this Recreation be made immediately after the former, as it easily may, by dextrously moving the pin, it will appear still the more extraordinary.

RECRE-

RECREATION XXXIII.

The magnetical cards.

ON the pasteboard circle mentioned in the preceding Recreation, instead of the twelve numbers, inscribe the four suits of the cards, and the eight cards of each suit that are used at piquet, in the following order :

Divisions.

1. Ace
2. King.
3. Knave
4. A heart
5. Queen
6. A diamond
7. An eight
8. A spade
9. A ten
10. A seven
11. A club
12. A nine,

as is expressed in Plate VII. Fig. 4. You must have two similar needles, which how-

however must be distinguishable by some private mark. These needles must have their opposite points touched. Of the eight cards of piquet inscribed on the circle there are only four that are of use here, which are those that are opposite the four pips: the others however are used in the second part of this Recreation.

When you place that needle or index on the pivot whose pointed end is touched, it will stop at one of the four pips against which you have placed the pin in the frame: then taking that needle off, and placing the other, it will stop at the opposite point.

Therefore desire a person to draw a card from a piquet pack, offering that card against which you have placed the pin of the dial, which you may easily do by having a long card, as is explained in the first volume. Tell the person who draws
the

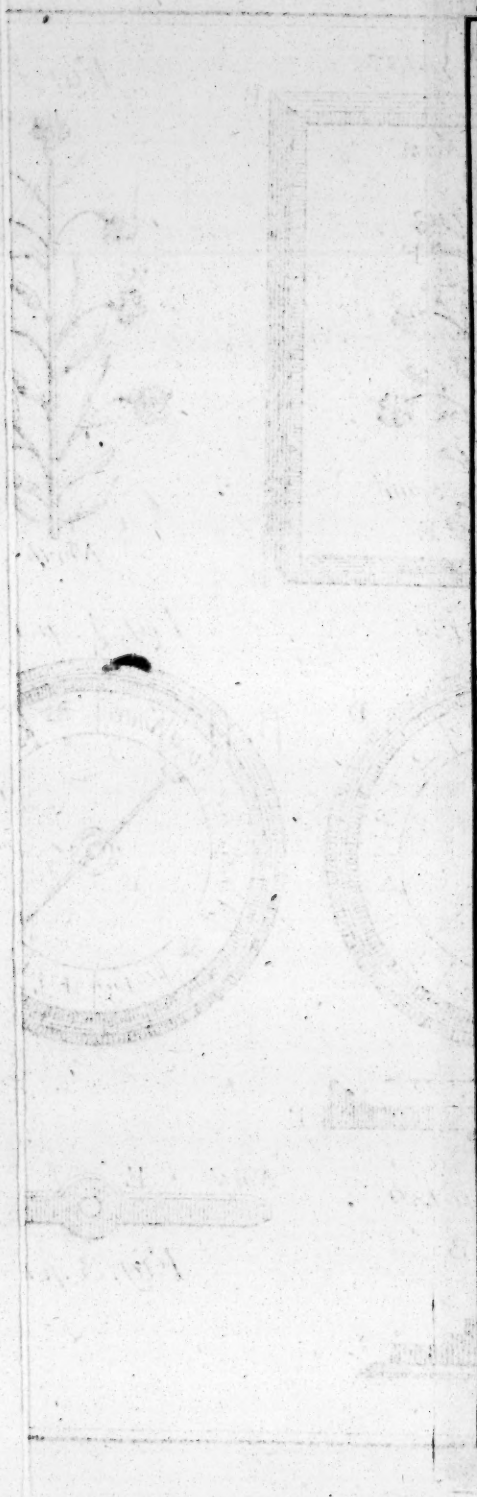


Fig. 1. p. 137.



Fig. 1.



Fig. 2. p. 139.

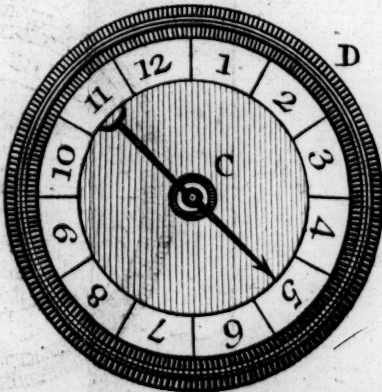


Fig. 4. p. 143.

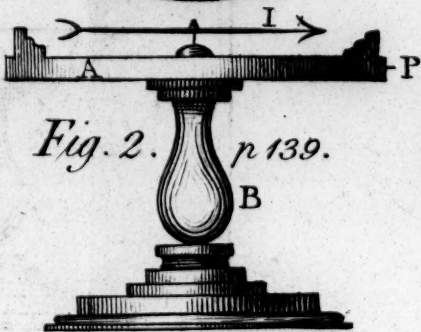
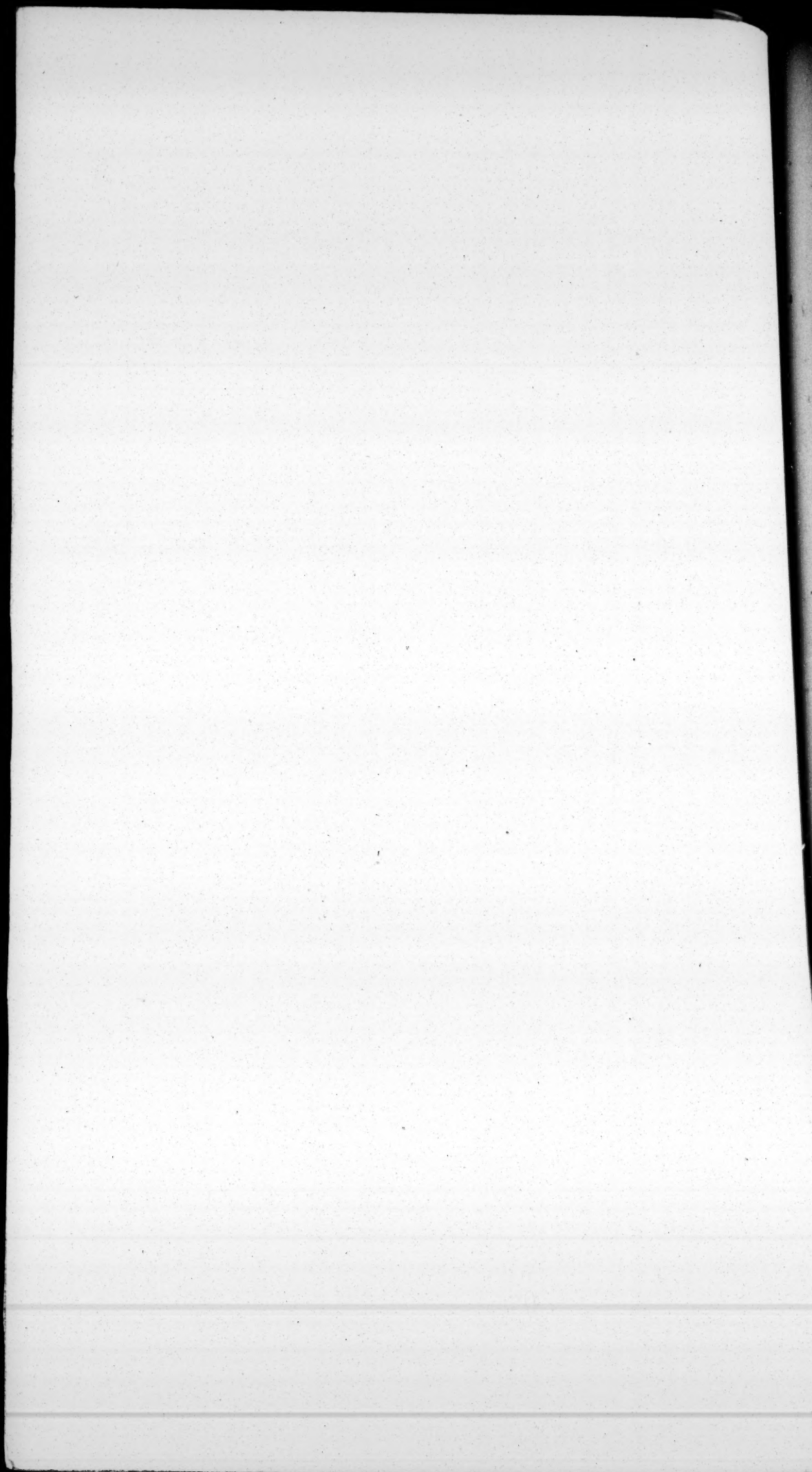


Fig. 2. p. 139.



Fig. 3. p. 140.



the card to keep it close, that it may not be seen. Then give him one of the two needles, and desire him to place it on the pivot and turn it about, when he will see it stop at the colour of the card he has chose: then taking that needle off, change it dextrously for the other, and give that to another person, telling him to place and turn it in like manner, and it will stop at the name of the card the first person chose.

If the first person should not draw the card you intend, you cannot directly perform this Recreation: therefore, to prevent any suspicion that you have failed in your design, cut the cards yourself at the long card, and let him put the card he drew under that card, then give them to one or more persons to cut, and when you perceive the long card is at bottom, you tell the person that the card he drew is at the top of the pack: and after this little

diversion you may begin the Recreation again.

The foregoing Recreation may be diversified by having a pack of piquet cards in which there are two longer than the rest, and that answer to two that are opposite each other on the circle, and were not used in the other Recreation. Then let two persons draw each of them one of those two cards.

Present the needle that will point to the second person's card to the first person: after which take it off, and changing it privately, present to the second person the needle that will point to the first person's card. You will observe that this Recreation does not show the particular suite in which the two cards were drawn.

RECRE-

RECREATION XXXIV.

The dextrous painter.

PROVIDE two small boxes as M and N, (Pl. VIII. Fig 1.) four inches wide and four inches and a half long. Let the box M be half an inch deep, and N two-thirds of an inch. They must both open with hinges and shut with a clasp. Have four small pieces of light wood, as OPQR in the same plate, of the same size with the inside of the box M, and about one third of an inch thick. In each of these let there be a groove, as AB, EF, CD, GH, these grooves must be in the middle, and parallel to two of the sides. In each of these grooves place a strong artificial magnet as V. The poles of these magnets must be properly disposed with regard to the figures that are to be painted on the boards; as is expressed in the plate. Cover the bars with paper to prevent their being seen; but take care in pasting it on

not to wet the bars, as they will thereby rust, which will considerably impair their virtue. When you have painted such subjects as you choose, you may cover them with a very thin clear glass.

At the center of the box N, place a pivot T, on which a small circle of pasteboard OPQR, Fig. 2. is to turn quite free; under which is to be a touched needle S. Divide this circle into four parts, which are to be disposed with regard to the poles of the needle, as is expressed in the figure. In these four divisions you are to paint the same subjects as are on the four boards, but reduced to a smaller compass. Cover the inside of the top of this box with a paper M, (see Fig. 1.) in which must be an opening D, at about half an inch from the center of the box, that you may perceive, successively, the four small pictures on the pasteboard circle just mentioned. This opening is to serve as the cloth on which the little painter

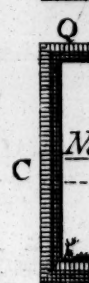


Fig. 1. p. 147.

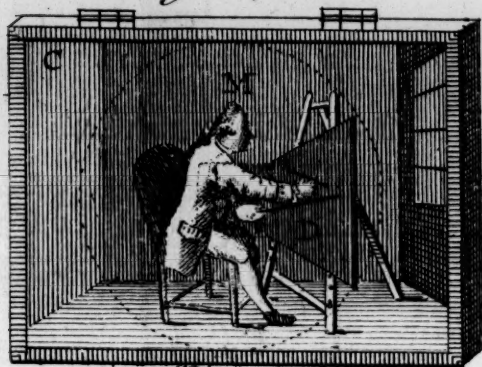


Fig. 1.

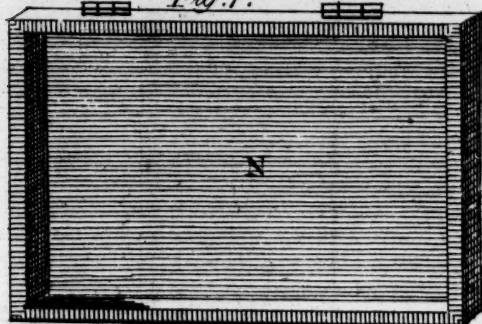
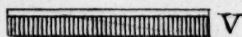
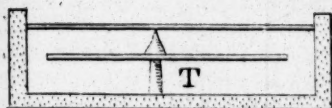
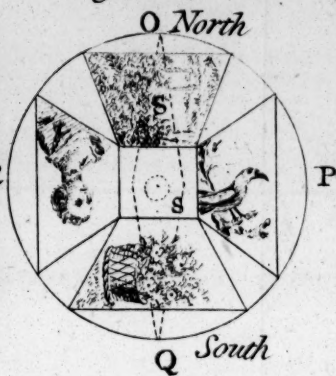
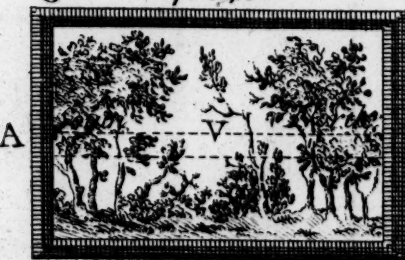
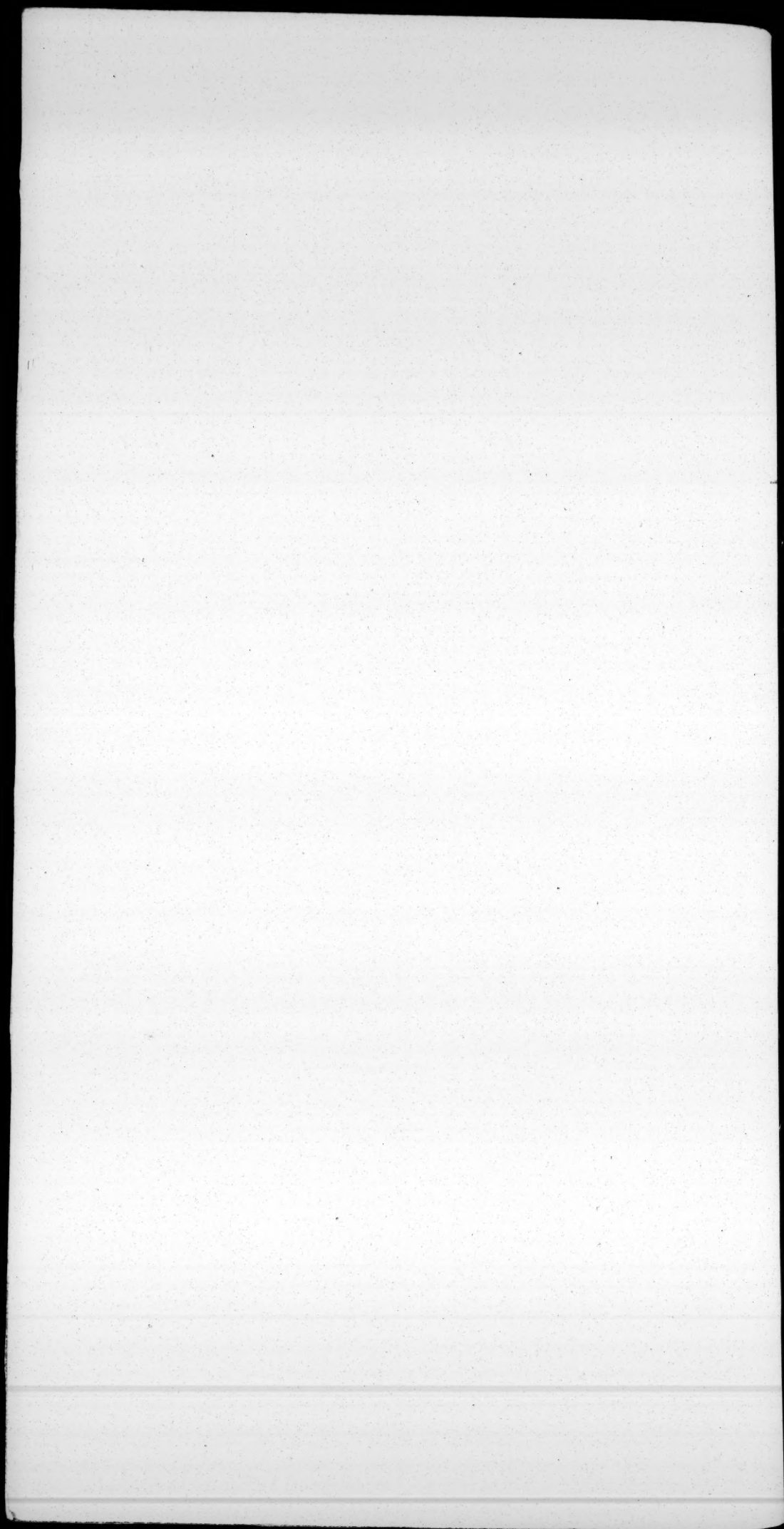


Fig. 2. p. 148.



O p. 148.





painter is supposed to draw one of the pictures. You may cover the top of the box, if you please, with a thin glass.

Then give the first box to any person, and tell him to place any one of the four pictures in it privately, and when he has closed it, to give it you. You then place the other box over it, when the moveable circle, with the needle, will turn till it comes in the same position with the bar in the first box. It will then appear that the little dextrous painter has already copied the picture that is inclosed in the first box.

RECREATION XXXV.

The cylindric oracle,

PROVIDE a hollow cylinder of about six inches high, and three wide, as AB, Pl. IX. Fig. 1. Its cover CD, must be made to fix on any way. On one side of this box or cylinder let there be a groove EF, nearly of the same length with that side; in which place a small steel bar as H, that is strongly impregnated; with the north pole next the bottom of the cylinder. On the upper side or the cover describe a circle, and divide it into ten equal parts, in which are to be wrote the numbers from one to ten, as is expressed at G. Place a pivot at the center of this circle, and have ready a magnetic needle. You are then to provide a bag, in which there are several divisions, like that described in the 32d Recreation. In each of these divisions put a number of papers,
on

on which the same, or similar questions, are wrote.

In the cylinder put several different answers to each question, and seal them up in the manner of small letters. On each of these letters or answers is to be wrote one of the numbers on the dial or circle at the top of the box. You are supposed to know the number of the answers to each question.

You then offer one of the divisions of the bag, observing which division it is, to any person, and desire him to draw one of the papers. Next put the top on the cylinder, with that number which is wrote on the answer directly over the bar. Then placing the needle on the pivot you turn it briskly about, and it will naturally stop at the number over the bar. You then desire the person who drew the question to observe the number at which the needle stands, and to search in the box

for a paper with the same number, which he will find to contain the answer.

You may repeat the experiment by offering another division of the bag to the same or another person; and placing the number that corresponds to the answer over the magnetic bar, proceed as before.

It is easy to conceive of several answers to the same question. For example, suppose the question to be, Is it proper to marry?

Answer 1. While you are young, not yet; when you are old, not at all.

2. Marry in haste, and repent at leisure.

3. Yes, if you can get a good fortune; for something has some flavour, but nothing has no flavour.

4. No, if you are apt to be out of humour with yourself; for then you will have two persons to quarrel with.

5. Yes,

5. Yes, if you are sure to get a good companion; for that is the greatest blessing of life. But take care you are sure.

6. No, if the person you would marry is an angel; unless you would be content to live with a devil.

RECREATION XXXVI.

The mystical dial.

IN a box, ABCD, (Plate IX. Fig. 2.) of about four inches square, and that shuts with a hinge, let there be an opening O, of three inches and a half square, and half an inch deep.

Provide four square pieces of wood E, F, G, H, Fig. 3. of the same size with the opening in the box. On these pieces describe the circles ILMN, which divide into four equal parts by the diagonals IM and LN, and then subdivide the parts NM and IL into four other equal parts: in each square piece

piece make a groove, as P, Q, R, S, and in each groove place a magnetic bar: then cover the squares with paper, and write on them the words two, six, eight, and twelve, as is expressed in the figure.

On another square piece, Fig. 4. of the same size with the surface of the box, describe a circle, and divide it into four equal parts by the diagonals MP and NO: then subdivide each of those four parts in four other equal parts; forming in the whole sixteen equal divisions, in which you are to write the numbers expressed in that figure. You will observe, that on the side MN are wrote the numbers that are in the other four squares; on the opposite side OP, the double of those numbers; on the side NP, the half of those numbers; and on the opposite side MO, the triple of the first numbers. Fix a pivot at the center of this circle, and on it place a magnetic needle.

You

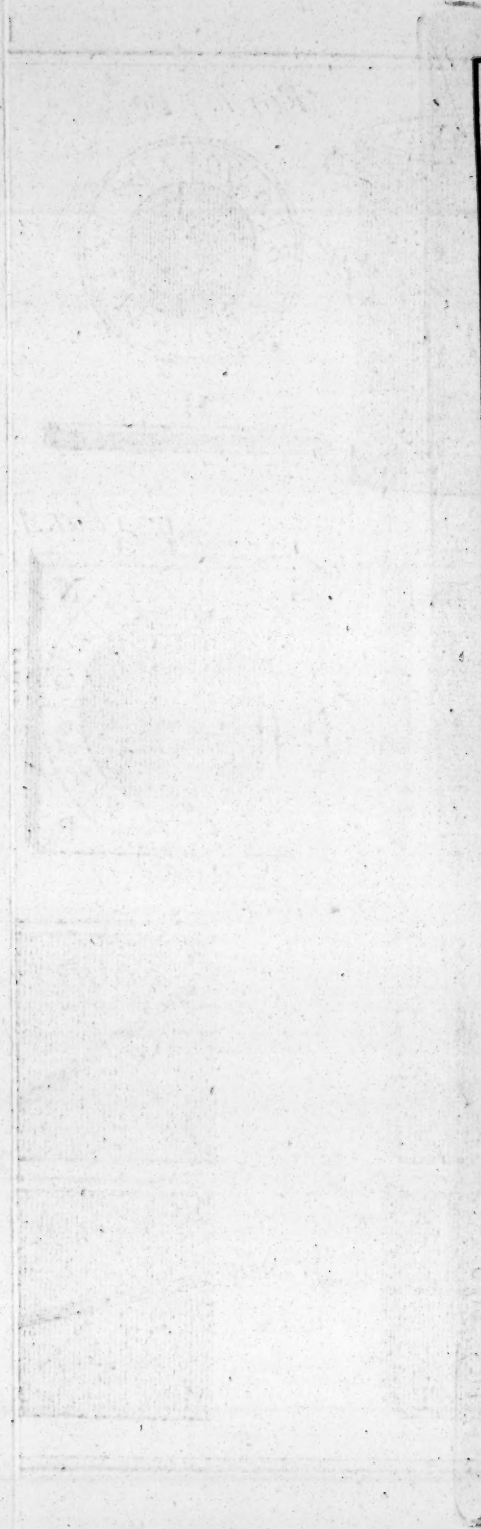


Fig. 1. p 150.

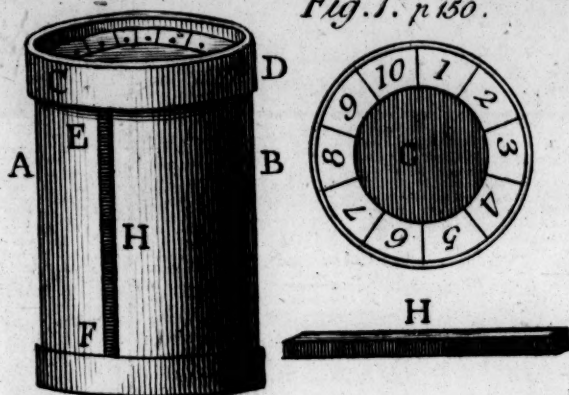
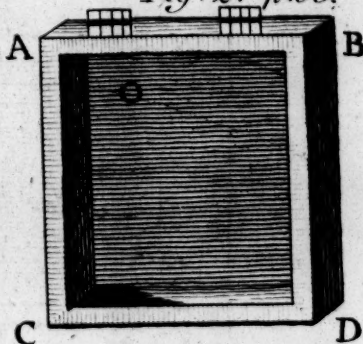


Fig. 2. p 153.



Number Fig. 4. p 154.

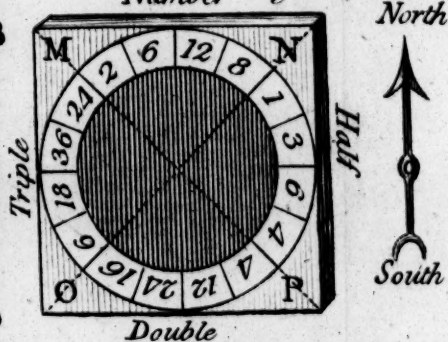
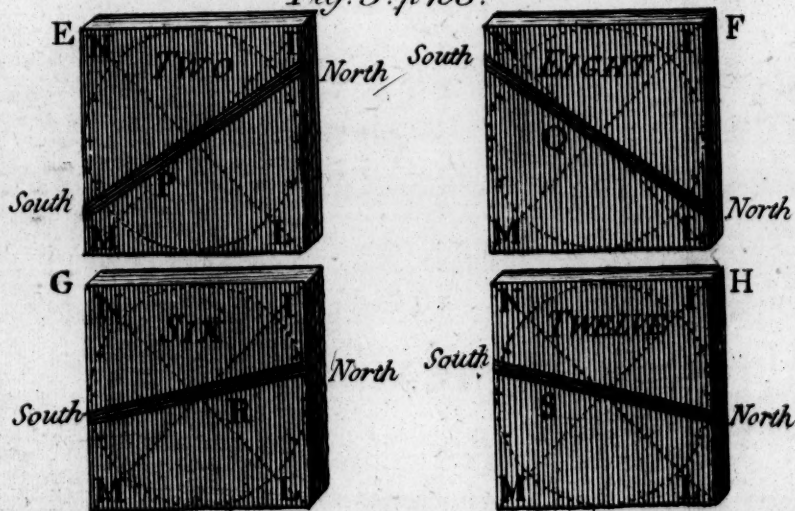
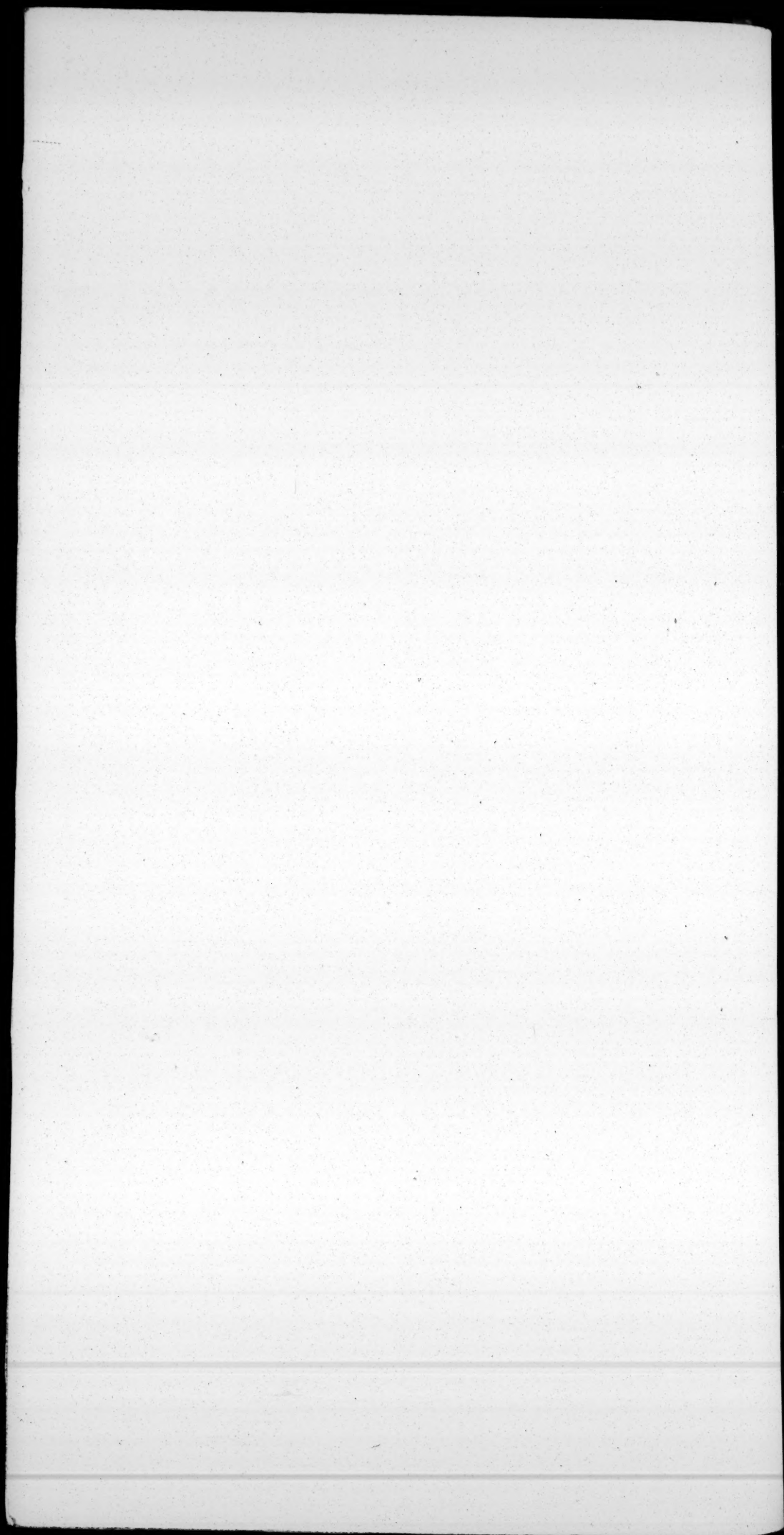


Fig. 3. p 153.





You then give the four square pieces to a person and desire him to put any one of them in the box, then to shut it, and place it himself on the table. He is next to choose whether the index of the dial shall point to the number of the square he has placed in the box, its half, its double, or triple; and you then place the dial over the box in the proper position. For the north pole of all the bars in the four square pieces being on the same side, the index will necessarily stop at that side; and consequently, as the dial is placed, will point to the whole, the half, the double, or triple of each number.

RECREATION XXXVII.

The enchanted ewer.

FIX a common ewer, as A, (Plate X. Fig. 1.) of about twelve inches high, upon a square stand BC, in one side of which there must be a drawer D, of about four inches square and half an inch deep. In the ewer place a hollow tin cone, inverted, as AB, Fig. 2. of about four inches and a half diameter at top, and two inches at bottom; and at the bottom of the ewer there must likewise be a hole of two inches diameter.

Upon the stand, at about an inch distance from the bottom of the ewer, place a small convex mirror H, Fig. 2, of such convexity that a person's visage, when viewed in it, at about fifteen inches distance, may not appear above two inches and a half long.

Upon

Upon the stand likewise, at the point I, Fig. 2, place a pivot of half an inch high, on which must be fixed a touched needle RQ, inclosed in a circle of very thin pasteboard OS, Fig. 3, of five inches diameter. Divide this pasteboard into four parts, in each of which draw a small circle: and in three of these circles paint a head as x, y, z , the dress of each of which is to be different, one, for example, having a turban, another a wig, and the other a woman's cap. Let that part which contains the face in each picture be cut out: and let the fourth circle be entirely cut out, as it is expressed in the figure. You must observe that the poles of the needle are to be disposed in the same manner as in the plate.

You are next to provide four small frames of wood or pasteboard, w, x, y, z , Fig. 4. each of the same size with the inside of the drawer. On these frames must be painted the same figures as on the circular pasteboard, with this difference,
that

that there must be no part of them cut out. Behind each of these pictures place a magnetic bar, in the same direction as is expressed in the plate; and cover them over with paper, that they may not be visible.

Matters being thus prepared, you first place in the drawer the frame *w*, on which there is nothing painted. You then pour a small quantity of water into the ewer, and desire the company to look into it, asking them if they see their own figures as they are. Then you take out the frame *w*, and give the three others to any one, desiring him to choose in which of those dresses he would appear. Then put the frame with the dress he has chose in the drawer, and a moment after, the person looking into the ewer will see his own face surrounded with the dress of that picture.

This Recreation, well performed, is highly agreeable. As the pasteboard circle

cle can contain only three heads, you may have several such circles, but you must then have several other frames: and the ewer must be made to take off from the stand.

RECREATION XXXVIII.

The magician's circles.

LET there be two boxes, A and B, (Pl. X. Fig. 5.) of about six inches square, and connected by the piece C, of one inch and a half wide. The depth of the boxes must be one inch, and that of the piece half an inch. In these boxes and the piece place the movement AB, Fig. 6, composed of two horizontal wheels, D and E, that have the same number of teeth, and two pinions F and G. The axis of the wheel D must pass through the top of the box; and on it must be placed a hand, by which it may be turned about: but that of E must end beneath the cover of the box; a magnetic bar being placed on it, and above the box, on a small pivot, must be placed a touched needle. This

movement should be so contrived as not to make any noise by its motion.

Draw a magic square in the following manner, consisting of twenty-five lesser squares, numbered; and each line of which whether read horizontally or perpendicularly, contains five words that give an answer to a question proposed. Let the five questions be as follows :

- | 1. | 2. | 3. | 4. | 5. |
|-----------|----------|---------|-------|--------------|
| 1. Are | you | pleased | with | matrimony? |
| 2. What | does | all | times | please? |
| 3. Should | we | wish | for | inheritance? |
| 4. Do | you | desire | more | riches? |
| 5. What | pleasure | is | most | desirable? |

Then draw the square thus.

Magic square.

1. I love	2. quite	3. well	4. my	5. husband
6. quite	7. pleases	8. what	9. wealth	10. brings
11. well	12. what	13. man	14. craves	15. delight
16. my	17. wealth	18. craves	19. much	20. increasing
21. husband	22. brings	23. delights	24. increasing	25. ever

On

On each side of the boxes place a square pasteboard of the same dimension, and on that of A draw a circle, and divide it into thirty equal parts. On that of B, draw likewise a circle, and divide it into fifteen equal parts. In the divisions of the circle A, write the words contained in the first five columns of the following table, which compose the foregoing questions in the order they are there numbered. That is, the word *are* in the first division, the word *be* in the second division, the word *you* in the third, the word *what* in the fourth division, &c. On the fifteen divisions of the circle B, write the words in the order they stand in the last column of this table. In the first circle the words must be wrote from right to left, and in the other from left to right.

Order of placing the words of the questions and answers on the two circles.

No.	1 question	2 question	3 question	4 question	5 question	No- Answers
1	{ 1 are 2 or 3 be	-	-	-	-	1 I love
2	3 you	4 what	-	-	-	2 quite
3	5 content	-	6 should	-	-	3 well
4	7 with	-	-	8 do	-	4 my
5	9 matrimony	-	-	-	10 what	5 husband
6	-	{ 10 does 12 or 13 can	-	-	-	6 pleases
7	-	14 we	-	-	-	7 what
8	-	15 all	-	16 you	-	8 wealth
9	-	17 please	-	-	18 pleasure	9 brings
10	-	-	{ 19 wish 20 or 21 pray	-	-	10 man
11	-	-	22 for	22 desire	-	11 craves
12	-	-	23 inheritance	-	24 is	12 delights
13	-	-	-	{ 25 more 26 or 27 greater	-	13 much
14	-	-	-	28 riches	28 most	14 encraving
15	-	-	-	-	{ 29 defirable 30 or 31 estimable	15 ever

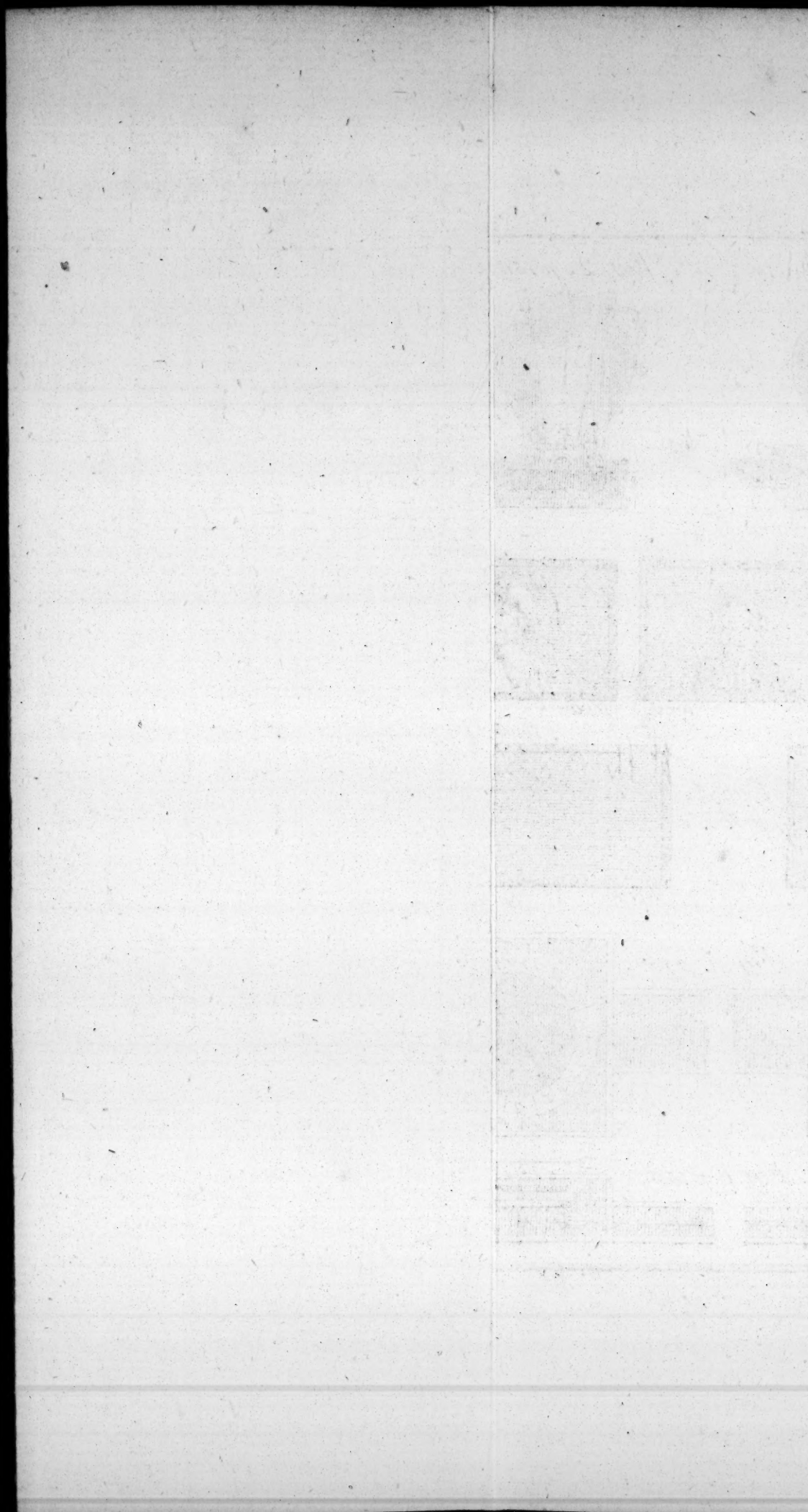


Fig. 1. p. 156.



Fig. 2. p. 156.

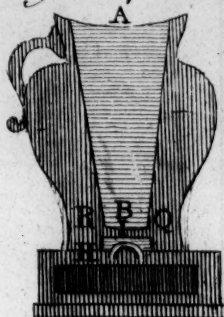


Fig. 3. p. 157.



North



North

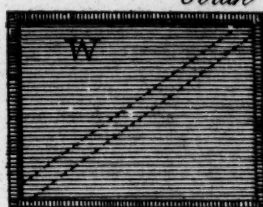


South



North

Fig. 4. p. 157.



North

Fig. 5. p. 159.

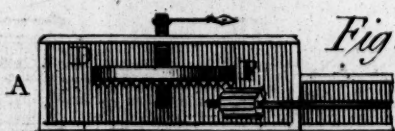
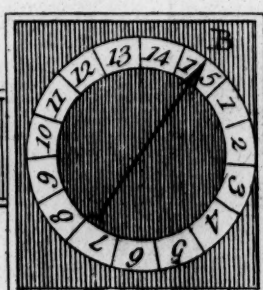
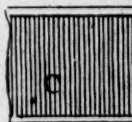
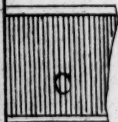
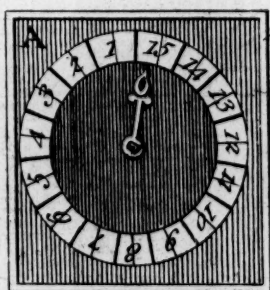
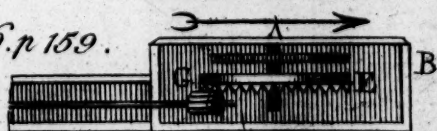
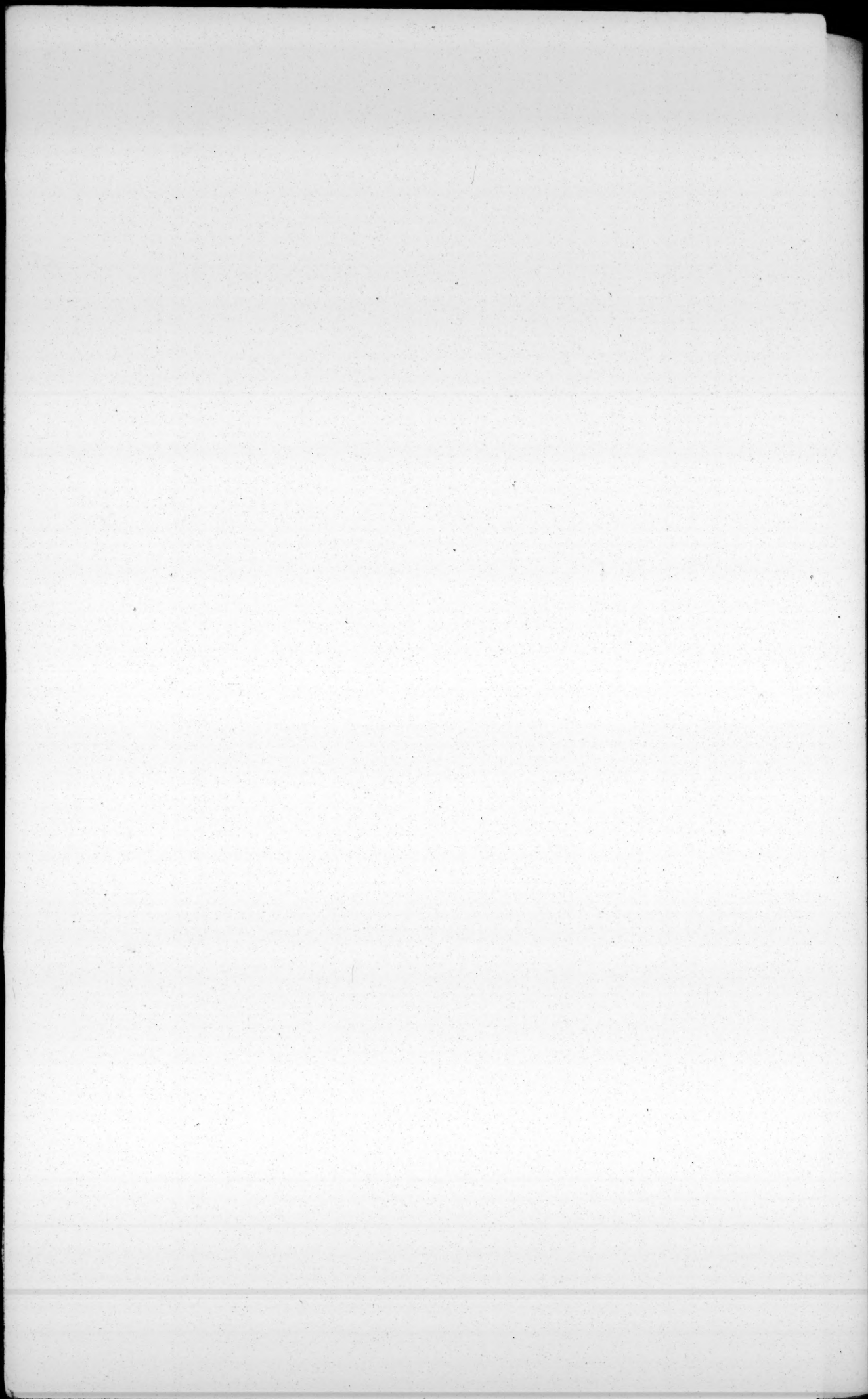


Fig. 6. p. 159.





The words being thus transcribed on the dials, the hands of both of them are to be placed to the corresponding divisions; for example, when the index of the dial A, is placed to the word *are*, that of the dial B, must direct to the division which contains *I love*; and so of the rest. You must then write on five cards the five foregoing questions, that is, one of them on each card.

Matters being thus prepared, you present the five cards to any person, and desire him to choose one of them, and then let him direct the index of the first dial successively to each of the five words which compose that question: while another person, placed by the dial to which the touched needle is placed writes down the words it successively points to, and they will be found to form the answer. The most remarkable circumstance in this recreation is, that the fifteen words on the dial B, give proper answers to the five

M 2

questions

questions on the other dial, which contain thirty words; and that every answer consists of the same number of words with the question.

These dials, by means of pullies, may communicate when placed on the opposite sides of a room: and this experiment may be diversified, by having several dials to place over the movement, with various words or figures: the foregoing serving only as a specimen of the manner of performing recreations of this sort.

RECREATION XXXIX.

The box and dice.

MAKE a hollow pedestal as CA, (Pl. XI. Fig. 1.) twelve inches long, nine wide, and one deep. The cover of this pedestal must be made to slide on and off, and not be above two-tenths of an inch thick. Toward the part A of the cover describe the circle B, which is to be

I divided

divided into twenty equal parts ; and on these parts mark the different points that can be thrown by two dice*. At the center place a pivot, on which a magnetic needle is to turn.

On the bottom of the inside of this pedestal, and directly under the circle at top, describe another circle M, which must be divided and marked in the same manner. At the center fix a magnetic bar by a screw, so that it may be easily placed in any position ; but not move of itself.

You must have two needles, the point of one being north and the other south : they should be in appearance quite similar ; but there must be, however, some mark by which you can distinguish them.

* The number of different points that can be thrown by two dice is twenty-one, of which there are only twenty here, as the divisions are obliged to be diametrically opposite each other : that number however is quite sufficient for the present purpose.

On the pedestal place a vase DE, of tin or pasteboard, about twelve inches high. In the side of the vase there must be two parts that open, one at FG, and the other at GH. These openings should not be deeper than the depth of one die, nor wider than two; and they must be made to shut quite close, that the places where they open may not appear. The cover of the vase D, must take off. There must be a communication between the top and the division GH, and in that division are to be placed two dice of any number. In that part IK must be placed the slider ST, which is exactly of the same length, and open next S, where must be placed two dice that contain the points at which one of the needles is to stop; and in the division FG, two other dice that are to contain the points at which the other needle is to stop: The bar within the pedestal is supposed to be previously fixed to the points that answer to the dice.

Matters

Matters being thus prepared, you open the part GH, and taking out those dice you throw them in at the top, and shew that they will fall into the same place again. You take them out a second time and give them to any person, telling him to throw them in at top. In the mean time you incline the vase toward your left hand, when the slider IK will come to GH, and thereby prevent the dice that are thrown in at top from falling into that division, by stopping up the passage. You then present him with the proper needle, which he places on the pivot and turns briskly about, and when it stops you tell him that the dice in the vase will have the same points with that division at which it has stopped. Which on your opening the upper division he will find to be true. You then take those dice out, and give them to another person: and taking the needle off the pivot dextrously change it for the other. You desire that person to throw the dice in at top, and

give him the proper needle : and when it stops, you open the division FG, and taking out those dice, he will find them also answer to the points on the division of the circle where the needle stopped.

RECREATION XL.

The box of flowers.

PROVIDE a box of light wood, eight inches long, five wide, and one inch and a half deep, (Pl. XI. Fig. 2.) provide also two cases, Fig. 3 and 4, five inches long, four wide, and an inch and a half thick. These must be made hollow on each side in the manner as is expressed in the profile E, In each of them there must be a groove that contains a bar O, strongly impregnated: the poles of these bars are to be disposed in the manner expressed in the figure: toward the part G, there must be a slider that holds a glass, and the sides of the cases must be closed.

In

In the four hollow parts in these two cases, and under the glasses, place four small natural flowers, of different sorts, and let them be in opposite directions, that is, the top of one flower to be level with the bottom of that on the other side.

In whatever position these cases are placed in the box, the poles of the bars next the hinges, will have a determinate direction. If the north pole of the bar attract the needle in the magnetic perspective at the point X, it is the rose that is there placed. If the south attract the needle, it is the jonquil. It will be the same when those two poles attract the needle at Z.

If the south pole attract the needle at the point Y, it is the carnation that is there placed. If the north pole attract it there, it is the hyacinth: and it will be the same when those two poles attract the needle at &. You must remember that
the

the north pole of the bar attracts the south of the needle, and the south the north. You therefore give the two cases, containing the flowers, to any one, and let him place them, in what position he please, in the box: and then, by the aid of the magnetic perspective, you tell him immediately where each flower is placed.

RECREATION XLI.

The box of metals.

PROVIDE a wooden box about thirteen inches long and seven wide, as ABCD, (Pl. XII. Fig. 1.) The cover of this box should be as thin as possible.

Have six small boxes or tablets, about an inch deep; all of the same size and form, as EFGHIK, that they may indiscriminately go into similar holes made in the bottom of the large box.

In each of these tablets is to be placed a small magnetic bar, and their poles are to

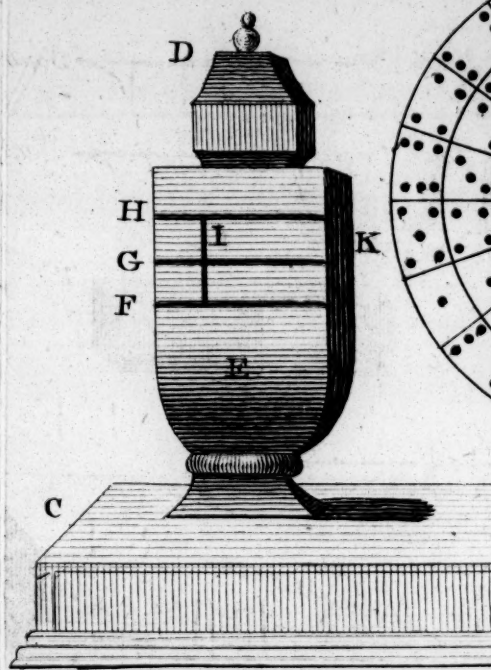


Fig. 2. p 168.

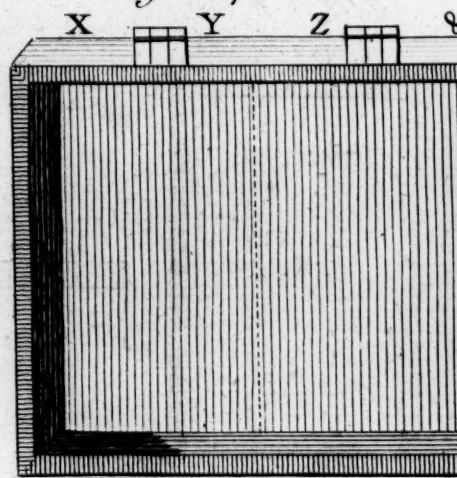


Fig. 1. p 164.

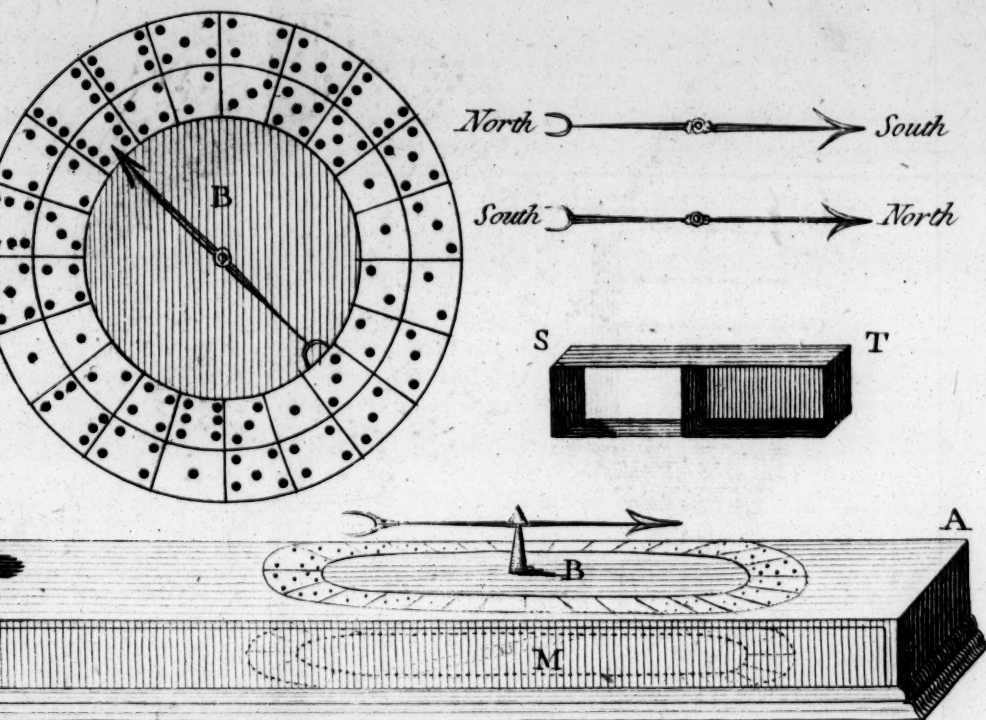
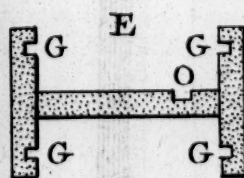
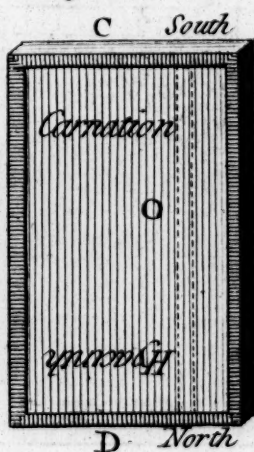
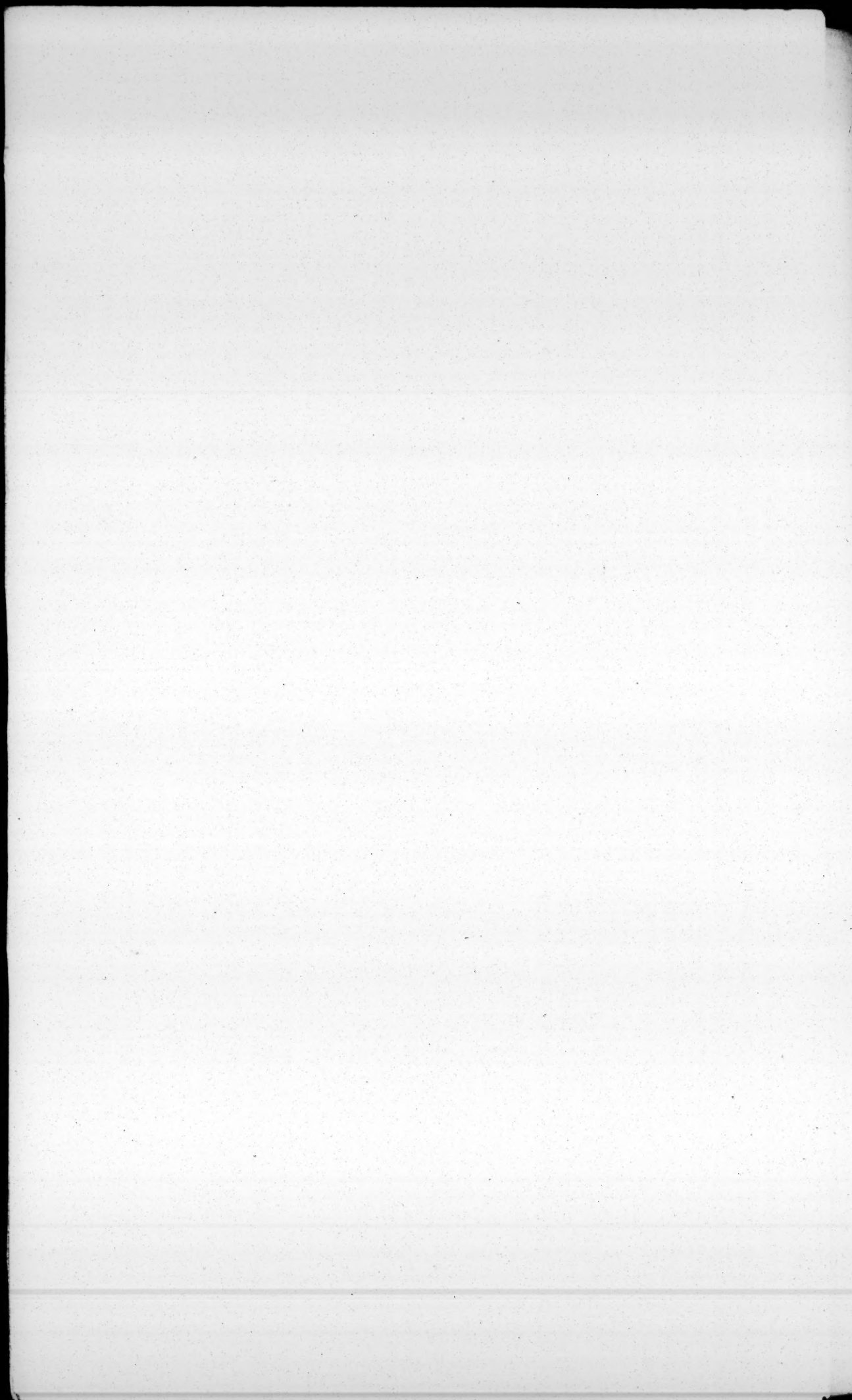


Fig. 3. p 168.



Fig. 4. p 168.





be disposed as is expressed in the figure. Cover each of these tablets with a thin plate of one of the six following metals; viz. gold, silver, copper, iron, pewter, and lead. You must also have a magnetic perspective, at the end of which is to be two circles, one divided into six equal parts, and the other into four, as in Fig. 2. from the center of which there must be drawn an index N, whose points is to be placed to the north.

Therefore, when you are on the side CD of the box, and hold your perspective over any one of the tablets that are placed on the holes E, F, G, so that the index drawn on the circle perpendicular to the side AB, the needle in the perspective will have its south pole directed to the letter that denotes the metal contained in that tablet. When you hold the perspective over one of the boxes placed in the holes H, I, K, so that the index drawn on the circle is perpendicular to the side CD,

CD, the fourth pole of the needle will in like manner express the name of the metal inclosed.

If the under-side of any one of the tablets be turned upward, the needle will be slower in its motion, on account of the greater distance of the bar. The gold and silver will still have the same direction, but the four other metals will be expressed by the letters on the interior circle.

If any one of the metals be taken away, the needle will not then take any of the above directions, but naturally point to the north; and its motion will be much slower.

You therefore give the box to any one, and leave him at liberty to dispose all the tablets in what manner, and with which side upward he please, and even to take any one of them away. Then by the aid of your perspective you tell him immediately the name of the metal on each tablet, and of that he has taken away.

This

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This box of metals* will, on comparison be found far to exceed that which has been publickly exhibited: for that being composed of six tablets, of which two only differ in form, admits but of six different dispositions, whereas in this the tablets may be placed 720 different ways. In the other you must also know the particular side of the box, which in this is not at all necessary. Nay, you may here distinguish each metal, though the box be completely covered with paper; for the effect of the needle will be always the same. The recreations with this box are therefore much more extraordinary, and its construction at the same time more simple.

* It was invented by the Duke de Pequigny, and by him communicated to M. Guyot.

RECREATION XLII.

The magnetic oracle.

IN a box a foot long, three inches and three quarters wide, and one inch deep, make three equal divisions, A, B, C, (Plate XII. Fig. 3.) Have eight small boxes or tablets of the same size with the division B of the box, into which they should go only one-fourth of an inch deep. In two of these tablets make a groove from the opposite angles, going from right to left, in which place the bars A, B, Fig. 4. and in two others a groove that goes in like manner from left to right, in which put the bars C, D. In two others a groove that divides them vertically into two equal parts, and place in them the bars E, F: and in the two last a groove that divides them horizontally, in which place the bars G, H. The poles of each of these bars are to be placed in the manner expressed in the figure.

Upon

Upon a board five inches square describe the circle NO, (Fig. 5.) which is to be divided into eight equal parts, in each of which write one of the numbers 1, 2, 3, 4, 5, 6, 7, 8, as in the figure, and let this board be placed on the part B of the box ABC.

Provide 32 small rundlets of wood or ivory, of three quarters of an inch long, and pierced with a hole of about one quarter of an inch in diameter, Fig. 3, and mark these barrels with the numbers 1, 2, 3, 4, 5, 6, 7, 8.

Then cover the tablets with paper to conceal the magnetic bars; and on each of them write some question, in such manner that the last word may direct to the north pole of the bar.

On small slips of paper write four different answers to each question, then roll them up and put them into the little rundlets.

rundlets. You must observe that the same number is to be wrote on four of the rundlets, and one of the four answers put into each of them, according to the direction of the needle of the dial. The little barrels being thus prepared, are to be placed on the two sides A and C of the box, Fig. 3.

You then give the eight tablets to any one, and leave him at liberty to place which of them he please on the box; which being done he is to turn the index round, and when it stops he is to choose one of those rundlets that are marked with the number where it stops, in which he will necessarily find the proper answer. To diversify this Recreation, the favourable answers may be placed on one side of the box, and the unfavourable on the other, so that you may tell him to choose either the one or the other.

RECREATION XLIII.

The incomprehensible card.

INSERT in the middle of a card, and parallel to its two longest sides, part of a watch spring, as thin as possible, and strongly impregnated: let it be so concealed as not to afford the least suspicion. This card should be a little longer than the others of the pack in which it is placed.

Offer any one to draw a card out of the pack, and present the long card dextrously to his hand. You then give him all the cards, and leave him at liberty to replace that card in the pack or not. He is then to lay the pack on the table, and by applying your magnetic perspective, you will discover whether the card be there or not.

If the person should not draw that card, you must be ready with some other recreation, to prevent suspicion of having failed in your design.

RECREATION XLIV.

The two magical cards.

PROVIDE a box ABCD (Plate XII. Fig. 6.) four inches square and three quarters of an inch deep. Cover its top with a pasteboard, in which there is an opening at A. At the center of this box let there be a pivot that supports a circle of pasteboard EF, on which is painted two cards: and at its center is to be a magnetic needle; as is expressed in the figure.

Now if you lay the magnetic wand, described at page 131, of this volume, so that the north pole of the bar it contains be next the middle of one of the sides of the box, the magnetic needle, with the
paste-

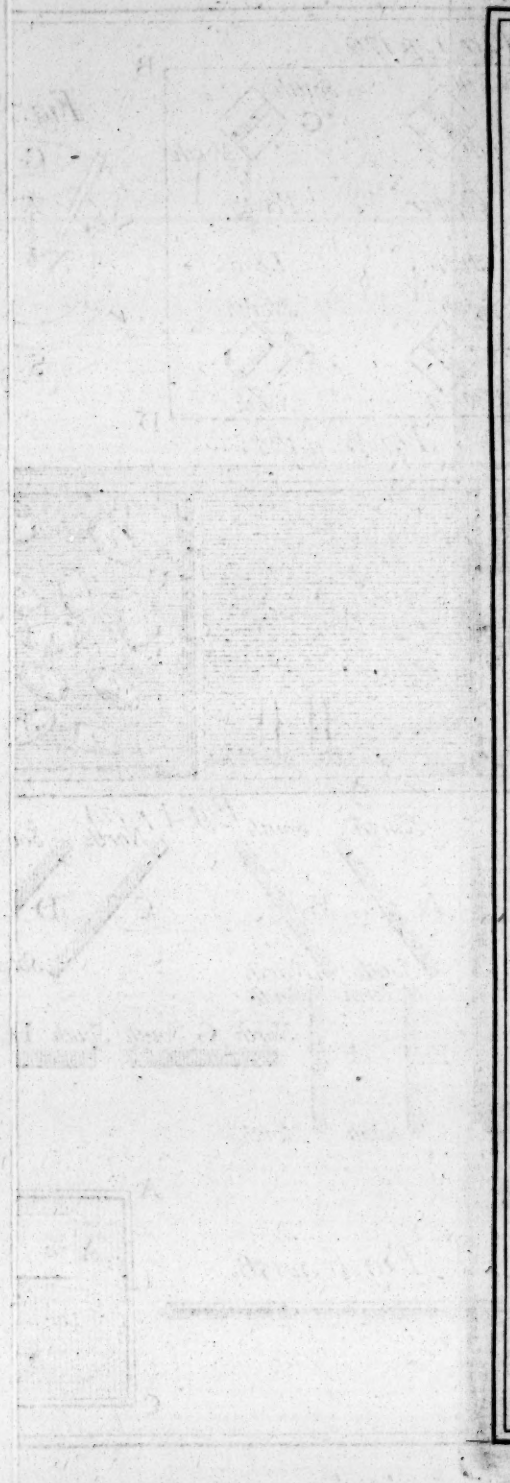


Fig. 1. p. 170.

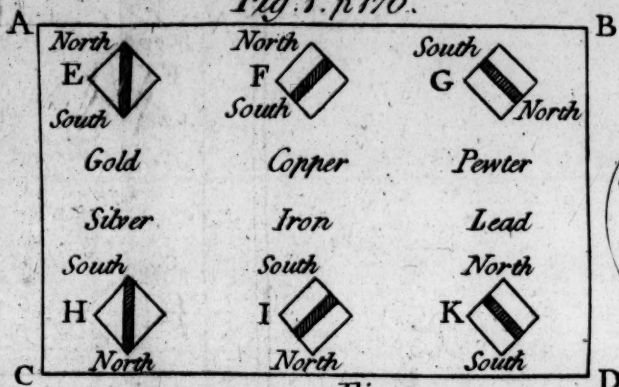


Fig. 2. p. 171.

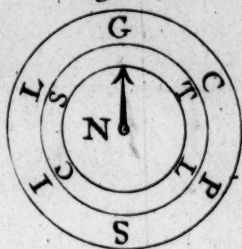


Fig. 3. p. 174.

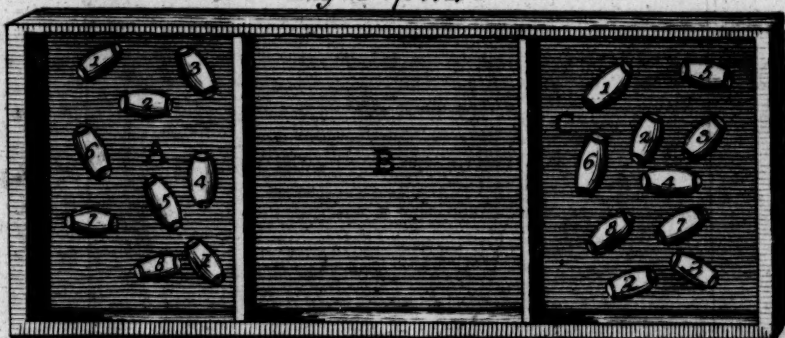


Fig. 5. p. 175.

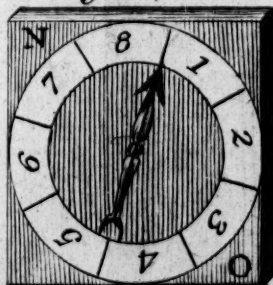


Fig. 4. p. 174.

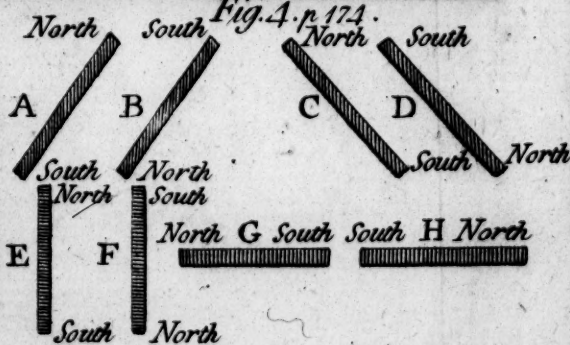
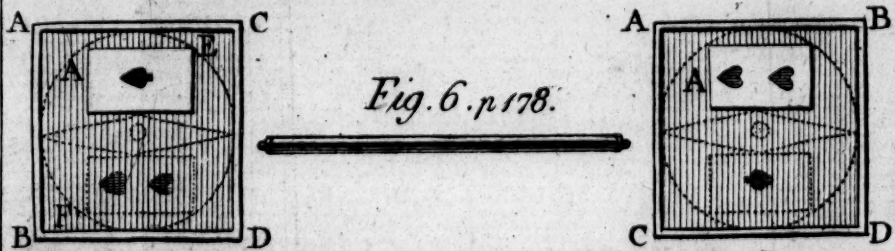
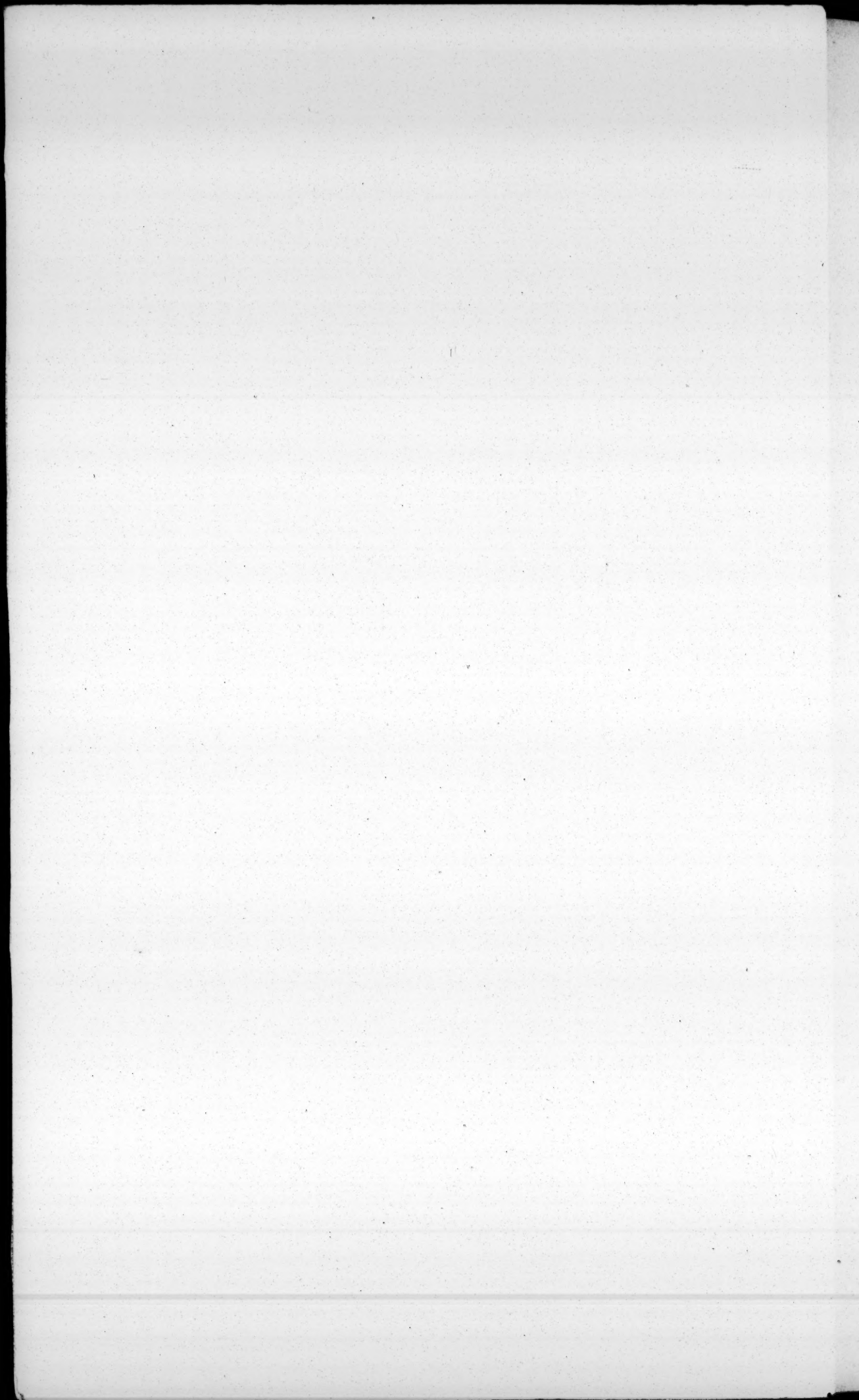


Fig. 6. p. 178.





pasteboard circle, will turn so that its south pole will be next the wand. But if the south end of the wand be next the box, the north end of the needle will present itself, and consequently one or the other of the cards will be visible. You must therefore have a pack of cards in which one of the same sort with those painted on the circle is a small matter longer, and the other, wider than the rest.

Being thus prepared, you desire two persons to draw each one card, taking care to present those two cards so artfully that they can scarce draw any other. Then holding the wand carelessly in your hand, you ask one of the parties whether his own or the other person's card shall appear first. You then touch the box with your magic wand, and lay it on the table, as if the more easily to open the box. After giving the needle a short time to settle, you open the box and shew the card desired.

To show the other card, you place the box on the table with the other side next the wand.

You may shuffle the cards before you offer them, as you will always distinguish by the touch where the two cards are. If the parties should not draw those two cards, you must be ready with some other amusement, that it may not be perceived you have failed.

RECREATION XLV.

The magnetic planetarium.

CONSTRUCT a round box ILMN, of eight or nine inches diameter, and half an inch deep, (Plate XIII. Fig. 1.) On its bottom fix a circle of pasteboard, on which draw the central circle A, and the seven circumjacent circles B, C, D, E, F, G, H. Divide the central circle into seven equal parts by the lines AB, AC, AD, AE, AF, AG, and AH, which
must

must pass through the centers of the other circles and divide each of them into two equal parts. Then divide the circumference of each of those circles into 14 equal parts, as in the figure.

You are likewise to have another pasteboard of the same figure, and divided in the same manner, which must turn freely in the box, by means of an axis placed on a pivot, one end of which is to be fixed in the center of the circle A. See Fig. 2.

On each of the seven smaller circles at the bottom of the box, place a magnetic bar, two inches long, in the same direction with the diameters of those circles, and their poles in the situations expressed in the figure.

There must be an index O, like that of the hour-hand of a dial, which is to be fixed on the axis of a central circle, and by which the pasteboard circle, in the box

N 3 may

may be turned about. There must be also a needle P, that will turn freely on the axis, without moving the circular pasteboard.

In each of the seven divisions of the central circle write a different question, and in another circle, divided into 12 parts, you may write the names of the 12 months. In each of the seven circles write two answers to each question, observing that there must be but seven words in each answer ; in the following manner.

In the first division of the circle G, which is opposite the first question, write the first word of the first answer. In the second division of the next circle write the second word ; and so on to the last word, which will be in the seventh division of the seventh circle.

In the eighth division of the first circle write the first word of the second answer ;
in

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in the ninth division of the second circle write the second word of the same answer ; and so on to the fourteenth division of the seventh circle, which must contain the last word of that answer.

The same must be done for all the seven questions, and to each of them must be assigned two answers, the words of which are to be dispersed through the seven circles.

At the center of each of these circles place a pivot, and have two sets of magnetic needles as QR, the pointed end of one set being north, and the other south.

Now, the index of the central circle being directed to any one of the questions, if you place one of the two magnetic needles on each of the seven lesser circles, they will fix themselves according to the direction of the bars on the corresponding

N 4 circles,

circles, at the bottom of the box, and consequently point to the seven words that compose the answer. If you place one of the other needles on each circle, it will point to the words that are diametrically opposite to those of the first answer, the north pole being in the place of the south pole of the other.

You therefore present this planetarium to any person, and desire him to choose one of the questions there wrote; and you then set the index of the central circle to that question, and putting one of the needles on each of the seven circles, you turn it about, and when they all settle they will point to the seven words that compose the answer. The two answers may be one favourable and the other unfavourable: and the different needles will serve to diversify the answers when you repeat the experiment.

The

RECREATIONS. 185

The moveable needle P, is to place against the names of the months; and when the party has fixed upon a question, you place that needle against the month in which he was born, which will give the business an air of more mystery.

At the center of the large circle may be the figure of the sun, and on each of the seven smaller circles, one of the characters of the five planets, together with the earth and moon. This Recreation, well executed, is one of the most entertaining that magnetism has produced.

CONSTRUCTION OF THE MAGNETICAL
AND MECHANICAL TABLE.

LET the table ABCD (Plate XIV, Fig. 1, and 2.) be constructed by an able workman, as near as possible after the following plan and dimensions.

First, this table must be five feet long, by two feet and a half wide. Its top must be only half an inch thick, except at the edge, which is to be one inch and a half thick, and go out beyond the feet of the table about an inch. This precaution is quite necessary, that the magnetic apparatus concealed beneath the surface of the table may be the nearer to the pieces placed on it; and that there may be no room to imagine that there are any parts concealed,

Secondly, the four feet E, F, G, H, Fig. 2. as well as the two cross-pieces L, L, must be hollow, being formed of

four pieces of wood half an inch thick, and two inches wide, and consequently the space between them a square inch.

In the third place, there must be a second surface to the table, placed under the other, and at one inch and a half distance from it. Fourthly, at one end of the table-frame, and parallel with the cross-pieces L, L, there must be a step M N, which joins to the frame; the joints of this step are likewise to be hollow and communicate with the two hind feet of the table. This table must be made with great care, that there may be no room to suspect there are any cavities in the legs or top: and if any of the joinings should appear, they must be painted to prevent all suspicion. The table being thus prepared may be covered with a green cloth, on which are to be placed the different pieces hereafter described, by which the subsequent recreations are to be performed,

On

On the side of the lower plane of the table next AB, at eight inches distance from the point O, and at the point P, fix the piece QR, Fig. 3, composed of a pulley S, of six inches diameter, and one third of an inch thick, on which is fixed a brass rod; to one end of which must be fastened two magnetic bars, eight inches long and bound together by four brass rings; or a single bar, strongly impregnated; or else an impregnated horse-shoe, placed as XYZ.

Beneath this pulley, and at its center, fix the brass barrel X, of one inch and a half diameter, and half an inch thick, in which fix the spring of a clock. At the end of the axis of the pulley, and beyond the brass barrel, let there be a square hole that is to come out, under the table, and close to it, and by which is to be fastened a small wheel with a catch, that the spring in the barrel may be contracted or extended at pleasure. Round the pulley let there

go a small string, such as is not much apt to dilate or contract*. It should pass over a small pulley near the opening into the foot H, and then over another at the bottom of the same foot †, and opposite to the communication with the step, that it may go behind the partition W.

Against the other side of the partition there is to be placed a table (Plate XV.) of two feet and a half long, and placed at a convenient height for the person who is to draw the string that communicates with the magnetic apparatus, clearly to distinguish the numbers, letters, and words there wrote.

The table is thus formed. First, measure the exact distance that the cord passes over while the pulley makes a com-

* It may be braided like a lace, as that is not much subject to contract.

† These pullies should be fixed on their axis, that they may not make any noise in turning.

plete revolution, and mark that distance on the table, as from V to Z.

Have three circles of wood, covered with paper, as A, B, and C, Fig. 1, 4, and 5. Divide that of A into 24 equal parts, and in each of those parts write one of the 24 letters of the alphabet. Divide the first column of the table into the same number of equal parts, and in each of them write the same letters and in the same order.

Then divide the circle B into 32 equal parts, in each of which write the name of one of the cards of piquet. Divide the second column of the table in the same number of equal parts, and in them write the same names in the same order.

Lastly, divide the circle C, into 18 equal parts, in each of which write one of the numbers from 1 to 15, and the three fractions $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$. Then divide the third column of the table into the same number
of

Fig. 1. p 186.

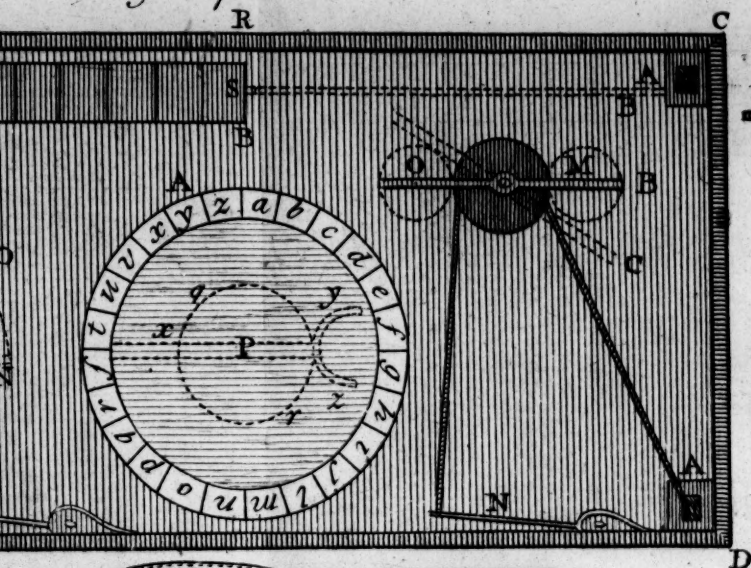


Fig. 3. p 188.

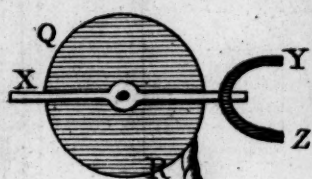
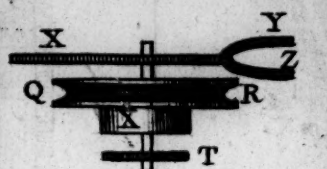


Fig. 4. p 190.

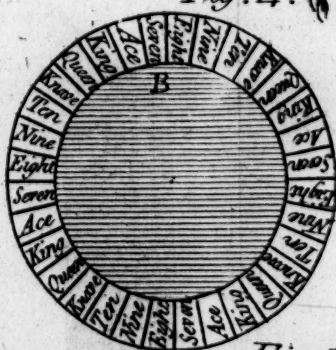


Fig. 5. p 190.

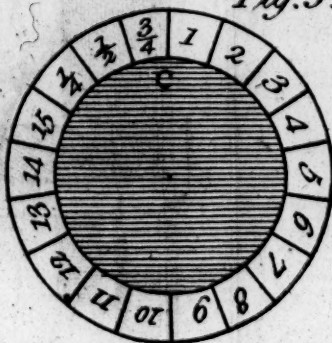
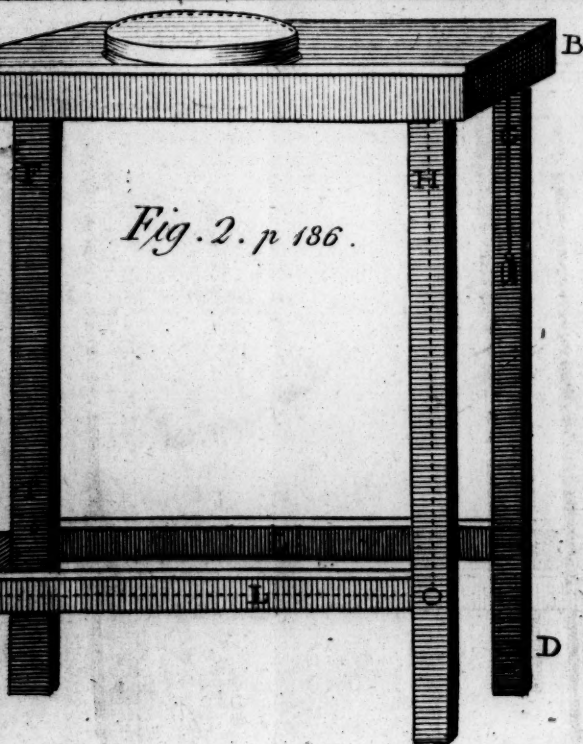
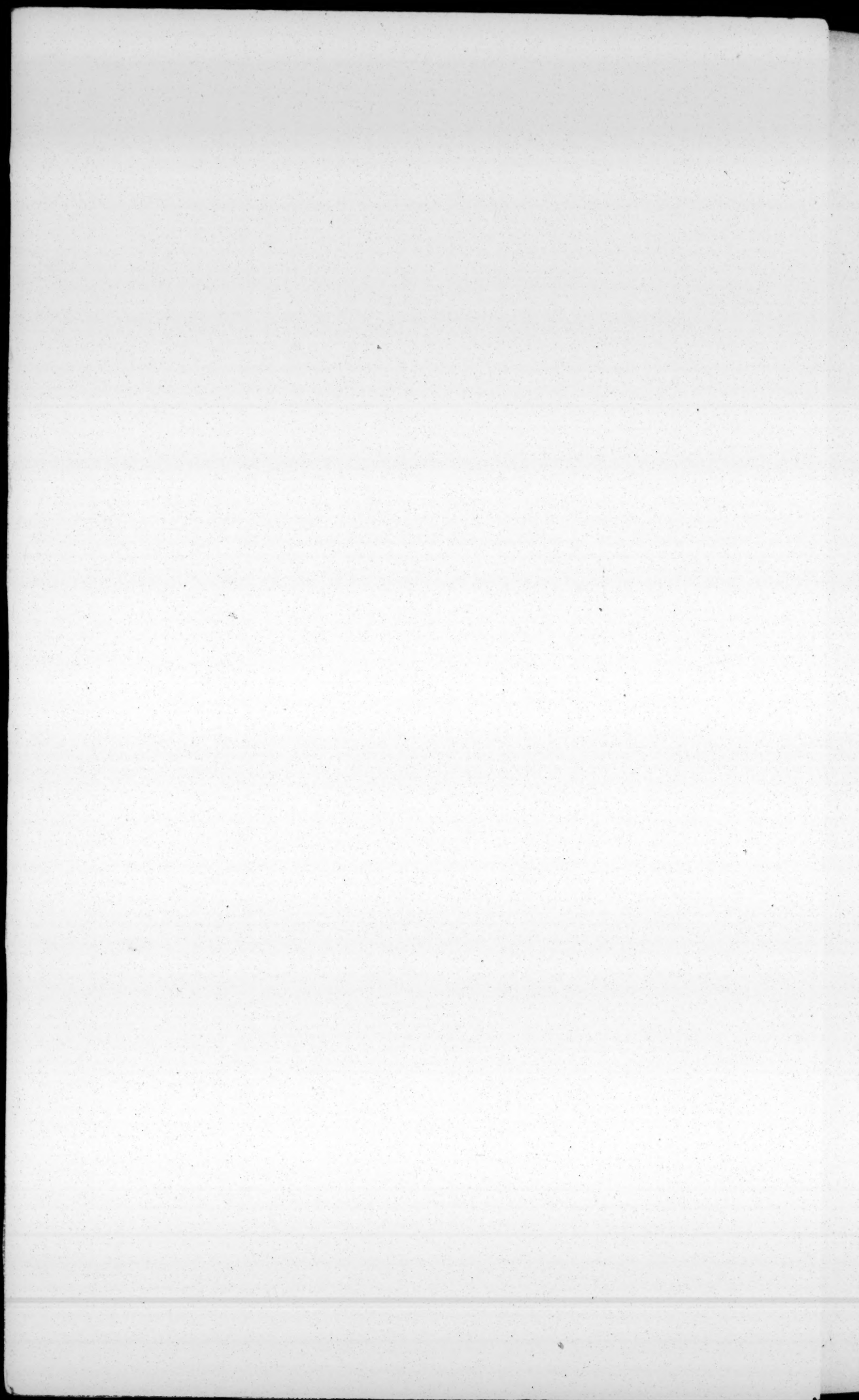


Fig. 2. p 186.





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of equal parts, and in them write the same numbers likewise*.

The pulley C must be placed above the table, and over it must run the string, at the end of which is to hang the weight D, sufficiently heavy to keep it distended, but not to put the pulley on the table in motion. To this string must also be annexed the wire or index E, which must be moveable, that it may be adapted to the unavoidable contraction or dilation of the string, occasioned by the moisture or dryness of the air : as otherwise it would not constantly answer to the divisions on the board.

Provide a copper basin, quite thin, about a foot in diameter, and one inch and a half deep. It should have two handles, that

* You may have other circles, on which may be wrote the 21 chances on the dice ; a number of answers to certain questions, and a great variety of other matters ; as every one's fancy will suggest.

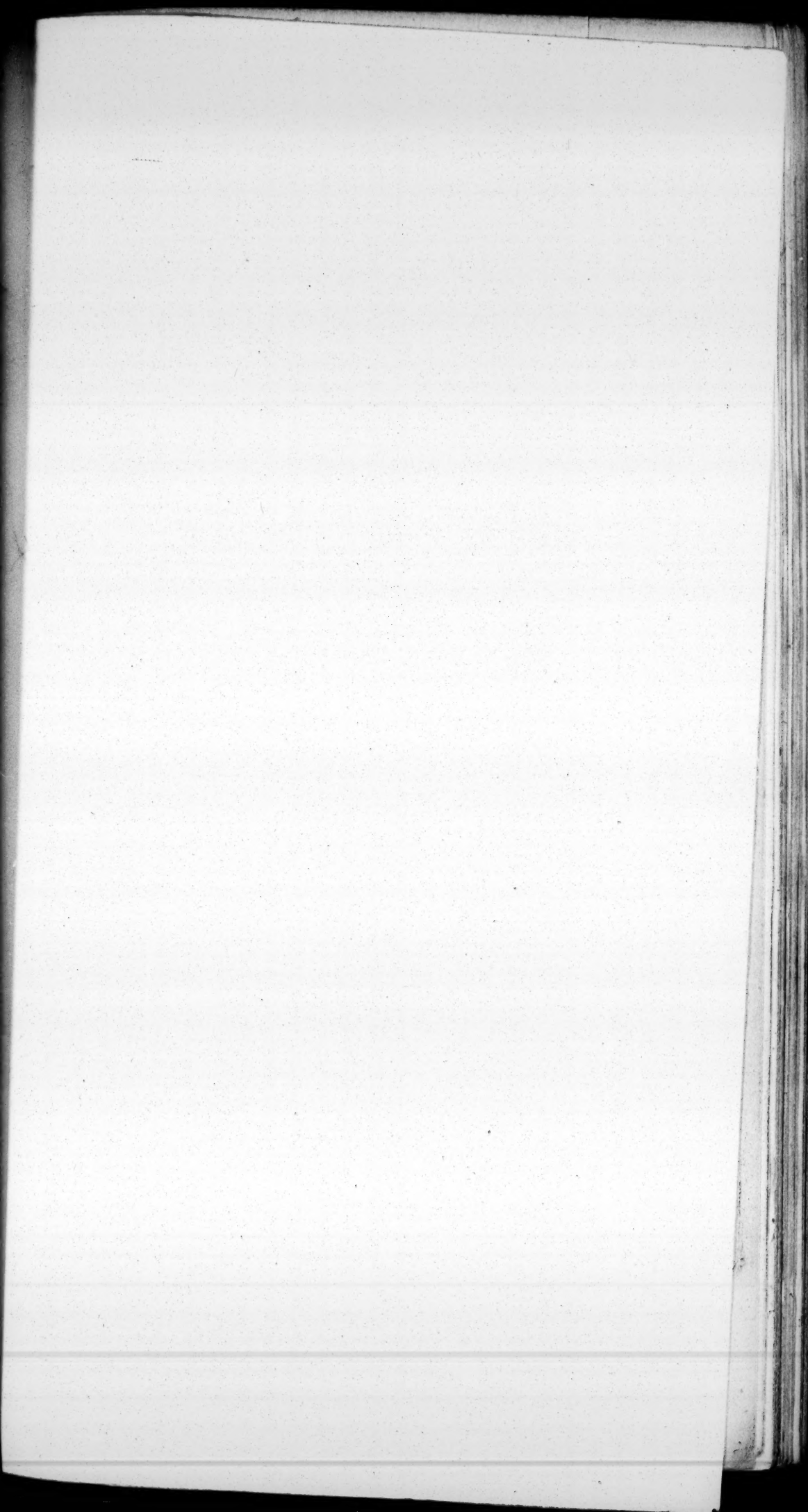
you

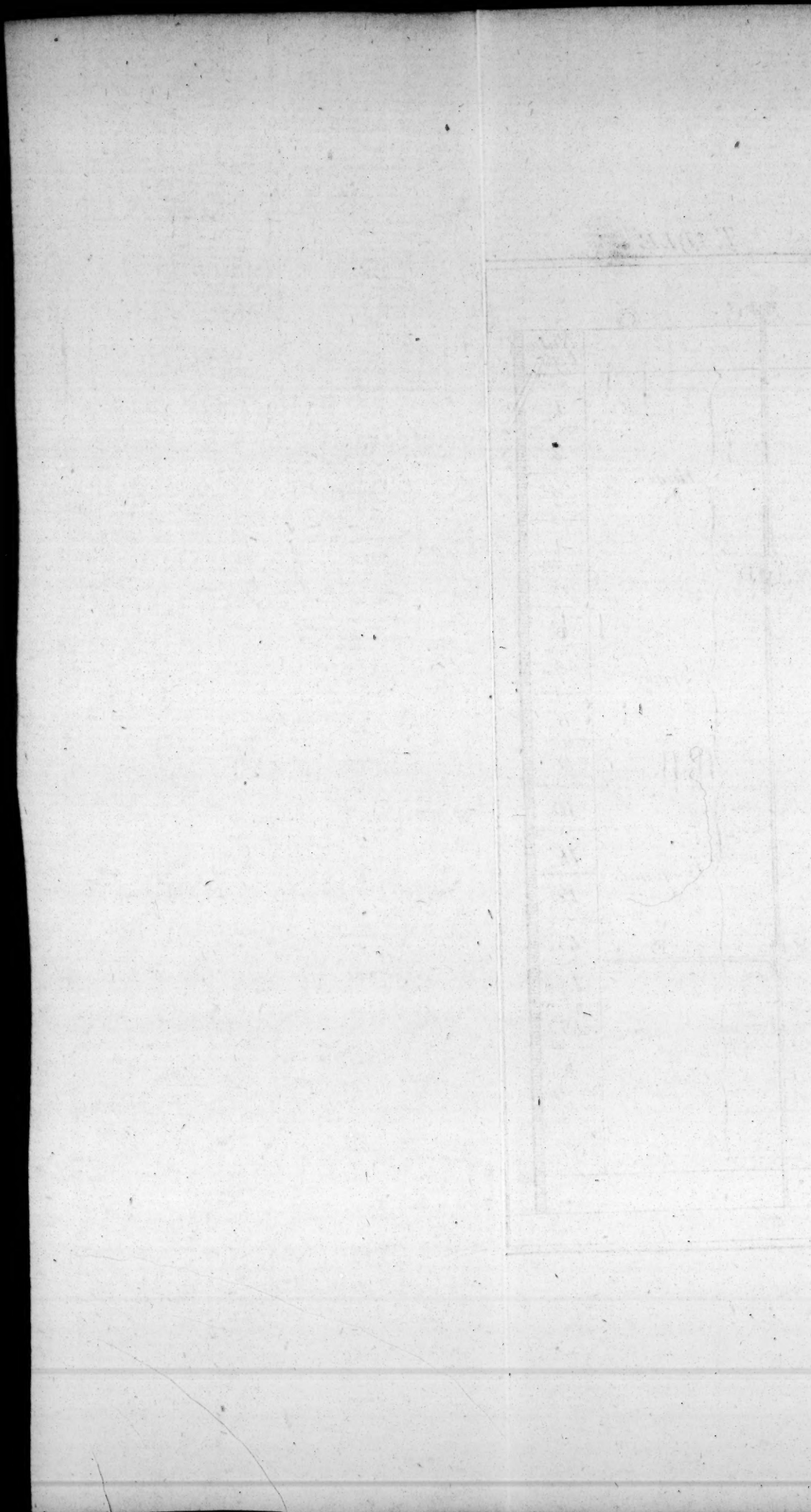
you may take it readily off the table without spilling the water. This bafon is to go into each of the circles described above. Each of those circles also must have a private mark, by which you may place it on the table in its proper position.

Then of very light wood or cork, make a small figure, in the shape of a firen or mermaid, in which is to be placed a magnetic bar, in a proper direction with regard to the magnetic horse-shoe. This figure is to float upon the surface of the water in the bafon*.

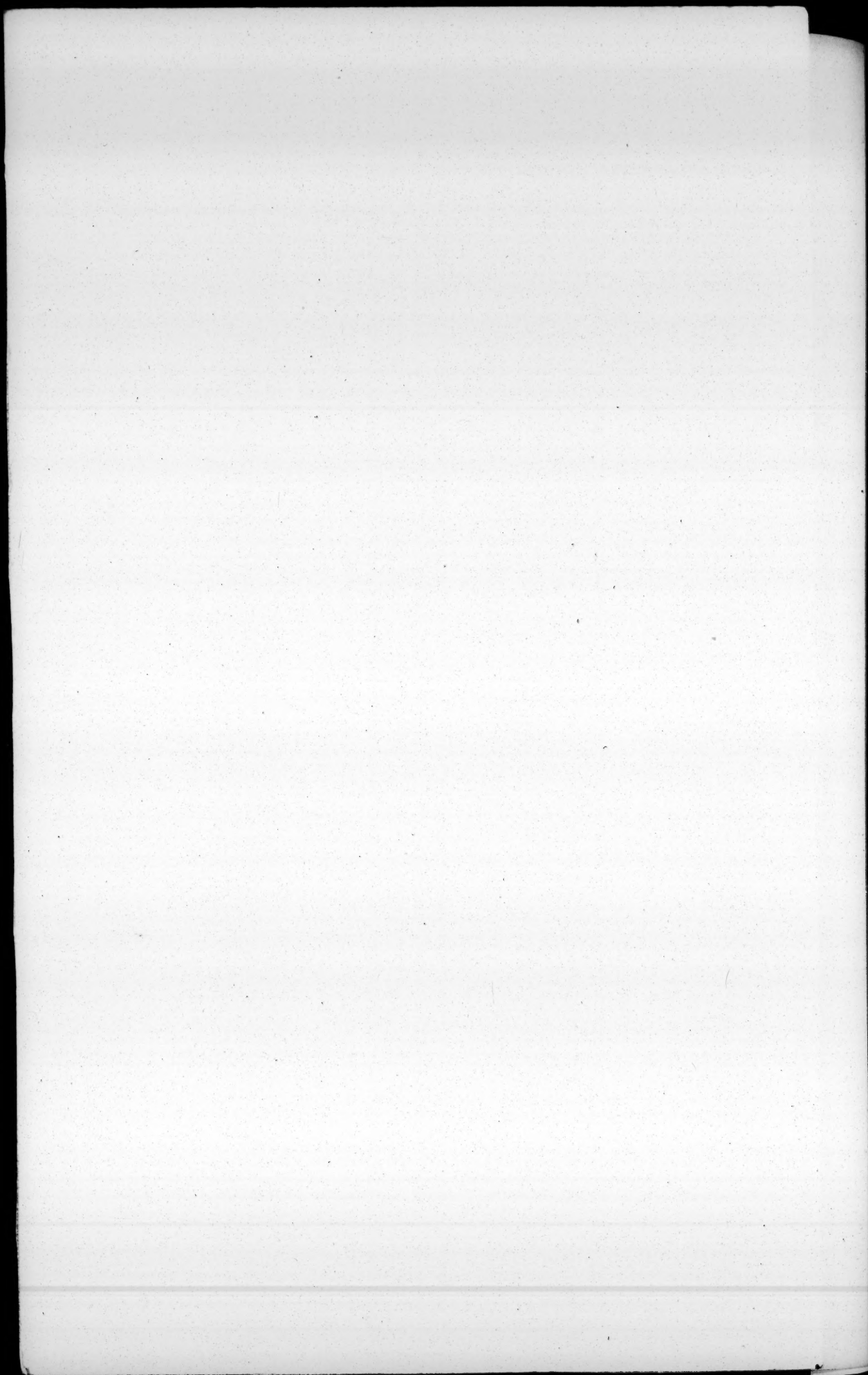
In the last place, part of the step at the bottom of the frame must be moveable, in the manner of a lever, and communicate with the other side of the partition, so as to be visible to the person behind it, but not to any one in the room where the machine stands.

* Instead of a firen you may form a small fish of very thin copper, and hollow ; or a small boat, or any other figure you please.





Letters	Cards	Num bers
A	Ace	1
B	King	
C	Queen	
D	Knave	
E	Ten	
F	Nine	2
G	Eight	
H	Seven	
I	Ace	
J	King	
K	Queen	3
L	Knave	
M	Ten	
N	Nine	
O	Eight	
P	Seven	4
Q	Ace	
R	King	
S	Queen	
T	Knave	
U	Ten	5
V	Nine	
W	Eight	
X	Seven	
Y	Ace	
Z	King	6
	Queen	
	Knave	
	Ten	
	Nine	
	Eight	7
	Seven	
	Ace	
	King	
	Queen	
	Knave	8
	Ten	
	Nine	
	Eight	
	Seven	
	Ace	9
	King	
	Queen	
	Knave	
	Ten	
	Nine	10
	Eight	
	Seven	
	Ace	
	King	
	Queen	11
	Knave	
	Ten	
	Nine	
	Eight	
	Seven	12
	Ace	
	King	
	Queen	
	Knave	
	Ten	13
	Nine	
	Eight	
	Seven	
	Ace	
	King	14
	Queen	
	Knave	
	Ten	
	Nine	
	Eight	15
	Seven	
	Ace	
	King	
	Queen	
	Knave	1/4
	Ten	
	Nine	
	Eight	
	Seven	
	Ace	1/2
	King	
	Queen	
	Knave	
	Ten	
	Nine	3/4
	Eight	
	Seven	
	Ace	
	King	



Now, matters being thus prepared, when you place the bafon on the table in one of the circles, so that its center is over the axis that turns the magnetic piece concealed in the table, if the person behind the partition draw the index in the string up to any one of the numbers, letters or words on Pl. XV. the magnetic piece on the table will place itself against the same number, letter, or word. Therefore, if you place the firen on the surface of the water, it will, by means of a magnetic wire concealed in it, direct itself to that part where the large bar or horse-shoe is moved. If the person behind the partition draw the wire up and down, before he fix it, the firen will in like manner make various motions, as if undetermined where to fix.

RECREATION XLVI.

To make the firen of the magnetic table point to all the letters of a given word.

YOU must have three cards, on which are wrote the names of three persons or cities, or any other words you please. One of these cards must be of the common size, another a little longer, and the third a little wider. These cards you give to any person, and desire him to choose which of them he thinks proper, and to keep it to himself. He is then to return you the two remaining cards, and you will discover immediately, by the touch, which card he has chose. You are previously to agree with the person behind the partition on the three different expressions, which denote the card that is chosen. For example, you are to say either, *The firen shall name the word; or she shall point to the letters that compose the word; or she will*

will find out the word. Then your confederate, after giving the siren some indeterminate motions, will direct her successively to the several letters that compose the word wrote on the card.

Note, the confederate must be of a ready apprehension; and to assist his memory, adjoining to the forementioned table, he should have a paper, on which are wrote the several signs you are to give him.

The siren is to point out the time expressed by any given watch.

You desire any person to lend you his watch, and laying it on the table, you tell him that the siren shall show the precise time at which it then is. You then mount the step, as if to place the watch more properly; and at the same time press down the moveable piece as many times as are equal to the hours. The person behind the par-

tition observing carefully that number, makes the firen point to it. You then make a similar signal for the quarters and minutes, and your confederate, in like manner as before, makes the firen point respectively to them.

To make the firen point to three numbers that have been chosen by three different persons.

You must have a small bag, like that described in the 32d Recreation of this volume, in which there are four divisions. In the first of them you must put the numbers from 1 to 15; and in each of the three others several tickets that have the same number, but not higher than 15. You draw out a handful of tickets from the first division, and show that they consist of different numbers. Then put them again in that division, and offer one of the other divisions to the three persons, from which they are each to draw a single number.

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number. Your confederate being previously informed what those three numbers are, and in what order they are to be drawn, will immediately direct the firen to them.

After the parties have drawn the three numbers, you may ask whether the firen shall point to their numbers separately, or to the amount of the whole. Suppose, for example, the three numbers be 5, 7, and 11. The firen is then made to point first to 2, and then to 3, which form 23, the amount of those numbers.

You may likewise let the same person draw two or three numbers, and the firen shall show him either those numbers separately, their amount, or their product when multiplied together.

A person having drawn a card from the pack, the siren points to the name of that card on the circle.

The person having drawn, from a piquet pack, the card that you have previously agreed on with your confederate, by your presenting that card in the manner already described, he immediately directs the siren to that card. It will be proper to agree on a second card with your confederate, that you may repeat the experiment if it should be desired.

A question being proposed by any person, the siren gives the answer; though the person who exhibits the Recreation does not know the question.

On five cards write five such different questions as may be all answered by the same word; as for example,

1. What can be in all parts of the earth at the same time?

2. What

2. What does the ivy round the oak ?
3. What must a man have to carry him
cross the ocean ?
4. What is it the hunter does with his
horn ?
5. What makes a great noise but no
show ?
6. What brings trees, towers and stee-
ples to the ground ?

All these questions are to be answered by the word wind. You therefore show that the cards contain different questions, and then give them to any person, telling him to choose one of them privately, and, keeping it to himself, to put the rest in his pocket; which being done, your confederate directs the firen to the letters that compose that word. If you would repeat the experiment, you must have another set of cards which have a different answer, that it may not appear that the same word answers all the cards. This recreation is

easily performed, and occasions no small degree of surprise.

The principal part of these recreations with the firen were invented by M. Guyot, and were therefore never exhibited in public before the appearance of his book.

RECREATION XLVII.

The sagacious swan.

PROVIDE a box XY, (Pl. XVI. Fig. 1.) eighteen inches long, nine wide, and two deep, the top of which is to slide on and off, at the end Y. Toward the end X, describe a circle of six inches diameter, round which are to be fixed six small vases of wood or ivory, of one inch and a half high; and to each of them there must be a cover,

At the end Y place an egg B, of ivory or other matter, of about three inches and a half

a half high, with a cover that shuts by a hinge, and fastens with a spring. It must be fixed on the stand C, through which, as well as the bottom of the egg, and the part of the box directly underneath, there must pass a hole of one-third of an inch in diameter. In this cavity place an ivory cylinder F, that can move freely, and rises or falls by means of the spring R. You must have a thin copper basin A, of six inches diameter, which is to be placed on the center of the circle at X, and consequently in the middle of the six vases.

Let a proper workman construct the movement expressed by Fig. 2. which is composed of a quadrant G, that has 16 teeth, and is moveable about an axis in the stand H, that has an elbow, by which it is screwed to the bottom of the box at L; and to the quadrant there must be joined the strait piece K. The horizontal wheel M, has 24 teeth, and is supported by the piece S, which is screwed to the end of the
box

box next X. On the axis of this wheel place a brass rod O P, five inches long, and at the part O place a large bar or horse-shoe, of a semicircular form, and about two inches and a half diameter, strongly impregnated. The steel rod V, takes at one end the teeth of the quadrant G, by the pinion F, and at the other end the wheel M, by the perpendicular wheel N, of 30 teeth; the two ends of this rod are supported by the two stands that hold the other pieces. Under the piece K, that joins to the quadrant, must be placed the spring R, by which it is raised, and pushes up the cylinder that goes through the stand C, into the egg.

You must also have six small etwees or cases as Y, Fig. 3. They must be of the same circumference with the cylinder in the stand, and round at their extremities: their length must be different, that when they are placed in the egg, and the lower end enters

enters the hole in which is the cylinder, they may thrust it down more or less, when the top of the egg, against which they press, is fastened down; and thereby lower the bar that is fixed to the end of the quadrant, and consequently, by means of the pinion F, and wheels N, M, turn the horse-shoe that is placed upon the axis of the last wheel*.

In each of these etwees place a different question, wrote on a slip of paper and rolled up, and in each of the vases put the answer to one of the questions; as you well know, by trials, where the magnetic bar or horse-shoe will stop.

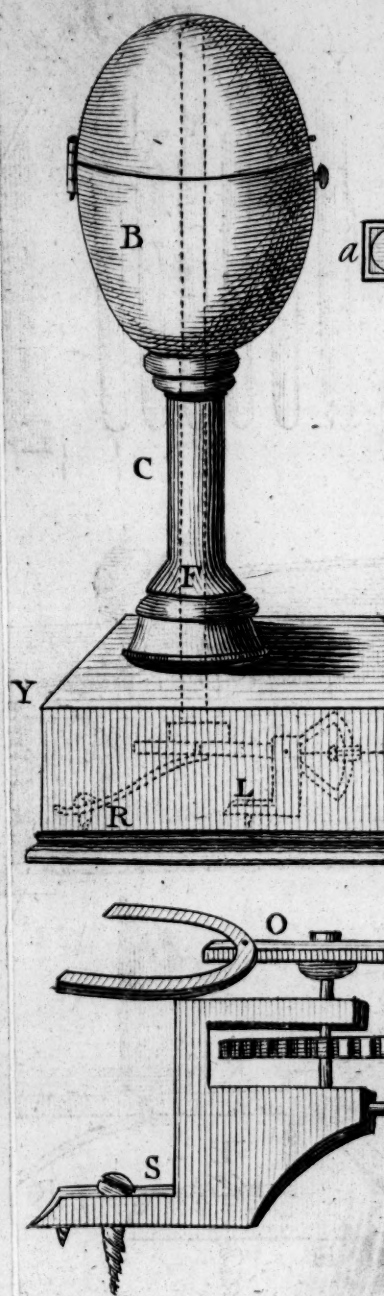
Lastly provide a small figure of a swan, or what other you please, made of cork or enamel: in which you must fix a touched needle, of the largest size of those commonly used in sewing.

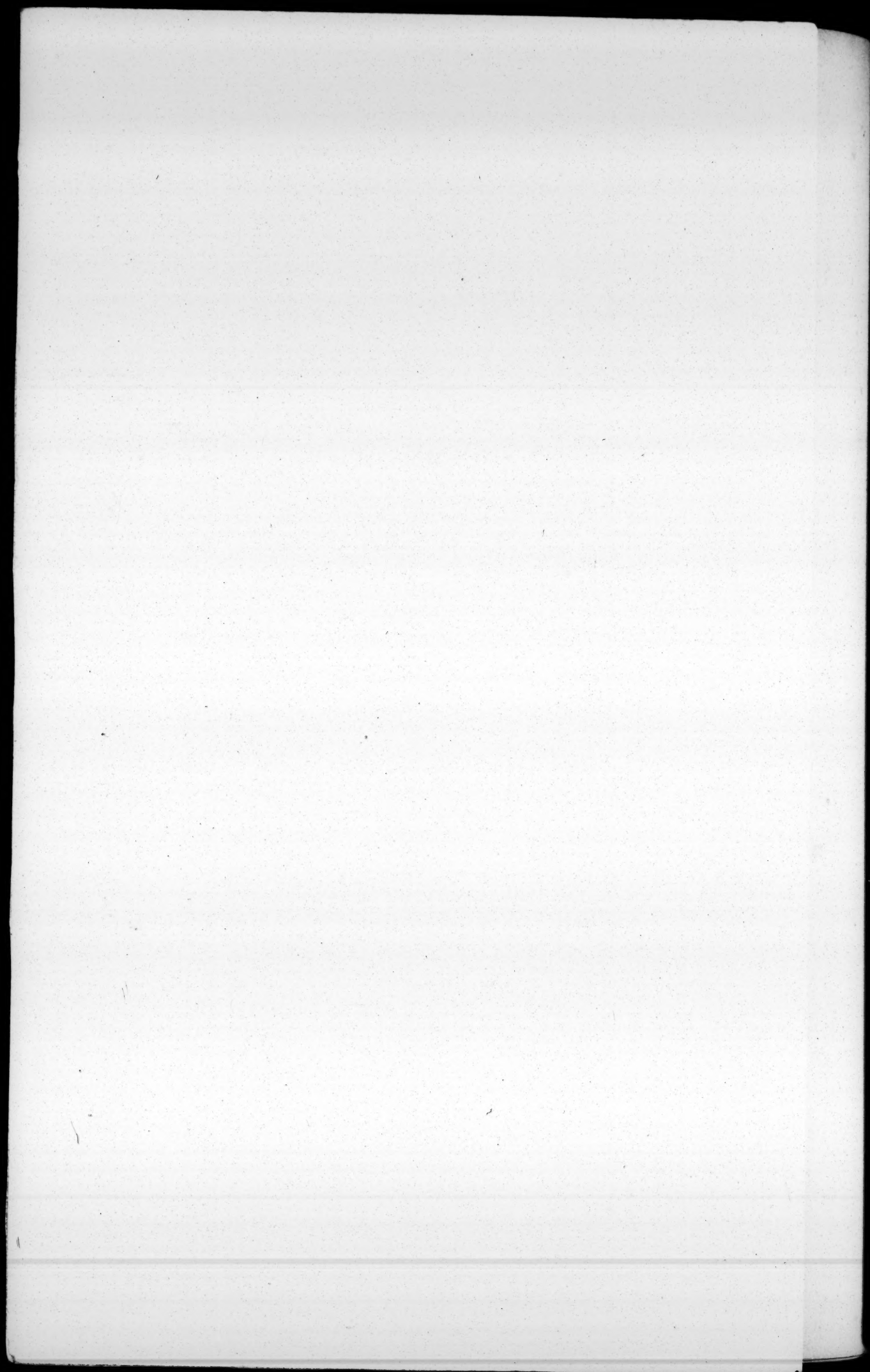
* The exact length of these etwees can be determined by trials only; which trials, however, may be made with round pieces of wood.

Being

Being thus prepared, you offer a person the six etwees, and desire him to choose any one of them himself, and conceal the others, or give them to different persons. He is then to open the etwee, read the question it contains to himself, and return the etwee to you, after replacing the question. You then put the etwee in the egg, and placing the swan upon the water in the basin, you tell the company she will presently discover in which of the vases the answer is contained. The same experiment may be repeated with all the etwees.

This apparatus is more commodious than that of the firen, as it may be easily moved from one place to another, and as there is here no occasion for a confederate. But at the same time it will not admit of so great a variety of experiments.





CONSTRUCTION OF THE COMMUNICATIVE BELL.

LET there be made a box of copper in the form of part of a hollow covered cylinder, as AB (Pl. XVII. Fig. 1.) This box must be placed upon the circle of wood C, that has at its center a pivot, on which is to be placed a touched needle D, three inches long, and thicker than the common needles; at each end it must have a very small brass knob, and near to one end of it there must be placed a small bell F, like that of a repeating watch; the bottom of this box must be closed with a gauze, that the needle may not be visible.

On the inside of the magnetic table, Pl. XIV, place a double bar MO, of about five inches long, strongly impregnated, and fixed on an axis, under which is placed a double pulley of an inch diameter. To one part of this pulley fix a small cord, the other end being fastened to the spring N.

From

From the other part of the pulley must go a cord that passes over another pulley at A, and from thence, through the leg H, and behind the partition W; in the same manner as in the experiment of the firen.

The motion of this cord being constantly the same, and of very little extent, a lever may be fixed behind the partition, by which the magnetic bar may be readily moved from B to C.

This preparation being made, when you place the copper box or cylinder on the table, in such manner that the pivot which holds the needle is directly over that which holds the magnetic bar in the table*, if the lever behind the partition be thrust down, the bar will be moved from B to C, and will cause the same motion in the needle, and consequently make it strike against the bell in the cylinder.

* There must be a mark on the cylinder, by which you will be directed in placing it on the table.

RECREATION XLVIII.

To tell by the communicative bell, the card that a person has drawn from the pack.

YOU are first to observe, that the founding of the bell signifies *yes*, and its silence *no*.

Open the pack before the person, and dextrously present that card to him which you have agreed on with your confederate. When the person has drawn that card you interrogate the bell, after the following manner. Suppose the card drawn to be the knave of spades.

Questions.	Answers.
Do you know the person that } has drawn the card ?	Yes.
Is it a gentleman ?	No.
Is it a lady ?	Yes.
Do you know her ?	Yes.
Is she handsome ?	Yes.
	Are

Questions.	Answers.
Are you sure you know the card?	Yes.
Is it a diamond—a heart—a club?	No.
Are you sure you are not mistaken?	Yes.
Is it then a spade?	Yes.
Is it the king—ten—nine of spades?	No.
Is it the knave?	Yes.

This manner of answering questions may be applied to various intentions: as to naming the hour, or the number of persons in company, &c. The foregoing Recreation is sufficiently common; the following is something more extraordinary.

To tell, by the bell, at what number, from the top, any card of a pack is, that a person shall name.

To perform this Recreation you must be provided with a piquet pack of cards, in which the several suites are placed in
the

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the following order, diamonds, spades, hearts, and clubs: and the cards of every suite in their natural rank, as ace, king, queen, knave, ten, &c.

You shuffle them, according to the manner prescribed in p. 79, of the first volume, and they will then be in the following order.

1 Knave	} clubs	17 Eight diamonds	
2 Ten		18 King	} spades
3 Eight	} hearts	19 Queen	
4 Seven		20 Knave	
5 King		21 Eight	
6 Queen		22 Seven	} hearts
7 Ten	} spades	23 Ace	
8 Nine		24 Knave	
9 Seven diamonds		25 Ten	
10 Ace spades		26 Nine	} clubs
11 Queen	} diamonds	27 Ace	
12 Knave		28 King	
13 Ace		29 Queen	
14 King		30 Nine	
15 Ten		31 Eight	
16 Nine		32 Seven	

A copy of this arrangement your confederate must have. Therefore when the person has named the card he chooses, he who is behind the partition hearing what card it is, either by the other's naming it, or your repeating it, by looking on his scheme will see the number at which it is placed, and immediately strike that number on the bell.

This Recreation is the more extraordinary, as it may be repeated a second or third time, by your shuffling the cards in a determinate order; nothing more being necessary than for the confederate to have a scheme of the situation of the cards after each shuffle.

RECREATION XLIX.

The magnetic balance.

YOU must have a small balance, such as is commonly used for weighing money, as AB (Plate XVII. Fig. 2.) It should be very exact, and the scales must be iron or steel, very thin, and gilt or lacquered. This balance must be supported by a stand fixed to the top of the magnetic table. The bottom of the scales should not be above half an inch distant from the table.

You must observe, that they are to be placed over that part of the table where is the magnetic bar that is used for the firen and bell; so that the centers of the two scales are to be over the points O and M. These scales must be strongly touched, that they may be the more easily attracted by the magnetic bar.

This preparation being made, you ask a person to lend you two pieces of money, suppose two guineas, and you place them in the scales, which will remain in equilibrium, if the pieces be of equal weight. You then propose to the person to augment the weight of either of them at pleasure, and when he has determined, your confederate behind the partition, by means of the lever, moves the bar toward one of the scales, and it immediately descends. You then, if required, make the same experiment with the other scale.

To give your confederate notice which scale is to be moved, nothing more is necessary than to say, is it *this*, or is it *that* scale; you having previously agreed with him which scale the words *this* or *that* shall signify.

RECREATION L.

The sympathetic dials.

LET there be two dials constructed of the same form and size. The movements of each consisting of a barrel A, and the four wheels A, B, C, D, with their pinions, and the fly F. The same as in the striking part of a clock or dial. (See Pl. XVII. Fig. 3.)

The movements of each of them must be enclosed between two plates of brass G and H, Fig. 4, of about two inches and a half diameter, and distant from each other about two-thirds of an inch. Let the axis of the wheel C pass through the center of the upper plate G, which is to be covered with a dial plate, that serves for ornament only. On the same axis place a needle or index, as in a common dial.

Under the plate H, Fig. 3, and on the axis of the barrel, continued out beyond the plate, fix a wheel with a catch, by which the movement of each of the dials may be wound up,

To one of these dials let there be a catch or trigger on the outside, by which it may be stopped or put in motion with a touch of the finger. To the other dial fix the catch LNM, whose axis is at N; the end L takes the fly of the movement, and consequently when the other end is thrust back the wheels are at liberty to move. This catch is to be placed on the brass wheel H, near the part I. It is to be of steel, well polished and touched, with its south pole at M. Great care must be taken to make this part move extremely free, that it may be easily attracted by the bar in the magnetic table, on which it is to be placed. Each of these dials is to be enclosed in a case of thin copper or brass QR.

On the inside of the magnetic table, Plate XIV. place the piece OP, composed of four steel bars strongly impregnated: they should be seven or eight inches long, half an inch wide, and one inch thick: they must be bound close together by four brass rings, of which that next P should be larger than the rest, and standing out beyond the bars, should have a hole thro' it, by which it is to be fixed on a pivot at P. These bars are to be drawn toward N, where they are to be stopped by the spring R. There must also be a string, which, passing over the pullies S and T, goes down the leg of the table; the bottom of which is to be a lever or treadle, under the step, by means of which the piece OP may be moved by your foot,

You therefore place the second dial on the table, directly over that part where the extremity of the bars OP is; when you put your foot upon the lever at the

P 4

bottom

bottom of the table. Therefore if you then place your foot on that lever, the bars attracting the end M, of the catch, will set the fly at liberty, and the wheels being put in motion, the index on the front of the dial will move with considerable velocity; but when you take your foot off the lever, the catch will again take the fly, and stop the movement.

Therefore having placed the second dial as above directed, you give the other dial, that had the end of the catch on the outside, to any person, and tell him, that when he shall stop it, or put it in motion, the dial on the table will, by sympathy, do the same, and by mounting the step you make it perform accordingly. You may also tell him that the dial on the table shall either stop or go, at his command: but this perhaps may destroy the notion of the dials acting by sympathy.

You

You may contrive to have stops or levers at different parts of the room, by carrying the cord under the floor: or in an adjacent room, to be moved by a confederate.

CONSTRUCTION OF THE MAGNETIC ROLLER.

PROVIDE a board two feet and a half long, three inches and a half wide, and half an inch thick, (see Plate XVII. Fig. 5.) and divide it into ten equal parts, in each of which describe a circle, and divide its circumference likewise into ten equal parts. In each of the circles make a groove, and in each groove place a magnetic bar, whose poles are to be disposed as in the figure. Under each end of the board place a roller, on which it is to move in the magnetic table, Plate XIV.

To the end A of the roller (see Pl. XIV.) fasten a cord, which is to pass over a pulley at B, and go down the leg of the table:

to the end of this cord is to be fastened a weight, inclosed in a bag, which is to pass freely up and down the hole at B. To the other end B of the roller, there must likewise be fastened a cord, which passing over a pulley at A, going down the leg of the table, and through the step at the bottom, comes out behind the partition W.

Against the other side of the partition place the table in page 220; and at the top of it fix a pulley, over which must pass a string, with a weight at the end, and to the string must be fastened an index; as in the experiment of the firen,

The table is formed in the following manner. You are first to determine by trials, the space that the index fastened to the string passes over, while each of the ten divisions of the roller comes to the point S, in the magnetic table, and mark them down on the plan. Then divide it into five columns. In the ten divisions of
the

RECREATIONS. 219

the first column write the numbers 10, 9, 8, 7, 6, 5, 4, 3, 2, 1. In the ten divisions of the second column write the vowels A, E, I, O, U, and the five consonants D, G, L, N, R. In the divisions of the third column write the figures 1, 2, 3, 4, 5, 6, 7, 8, 9, 0. In the fourth column, in every other division, write the name of one of the five following cards, eight of spades, seven of spades, eight of diamonds, seven of diamonds, ace of spades. In the fifth column write, after the same manner, the names of five states, as England, Portugal, Spain, Prussia, Austria. You may place what other letters you please in the second column, but they should be such as by their combinations will produce several words. The words in the fourth and fifth columns may likewise be changed for such as will answer to any other questions you choose.

TABLE.

RATIONAL T A B L E.

Divisions	Letters	Figures	Cards	States
10	A	1		England
9	E	2	8 spades	
8	I	3		Portugal
7	O	4	7 spades	
6	U	5		Spain
5	D	6	8 diamonds	
4	G	7		Prussia
3	L	8	7 diamonds	
2	N	9		Austria
1	R	0	ace spades	

Now it follows from what has been said, that when the person behind the partition fixes the index in the cord against any one of these divisions, the part of the roller which corresponds to that division will be brought opposite to the point S, in the magnetic table, and consequently the touched needles in the pieces hereafter described, will place themselves in the same direction with the bar in that part of the roller.

RECRE-

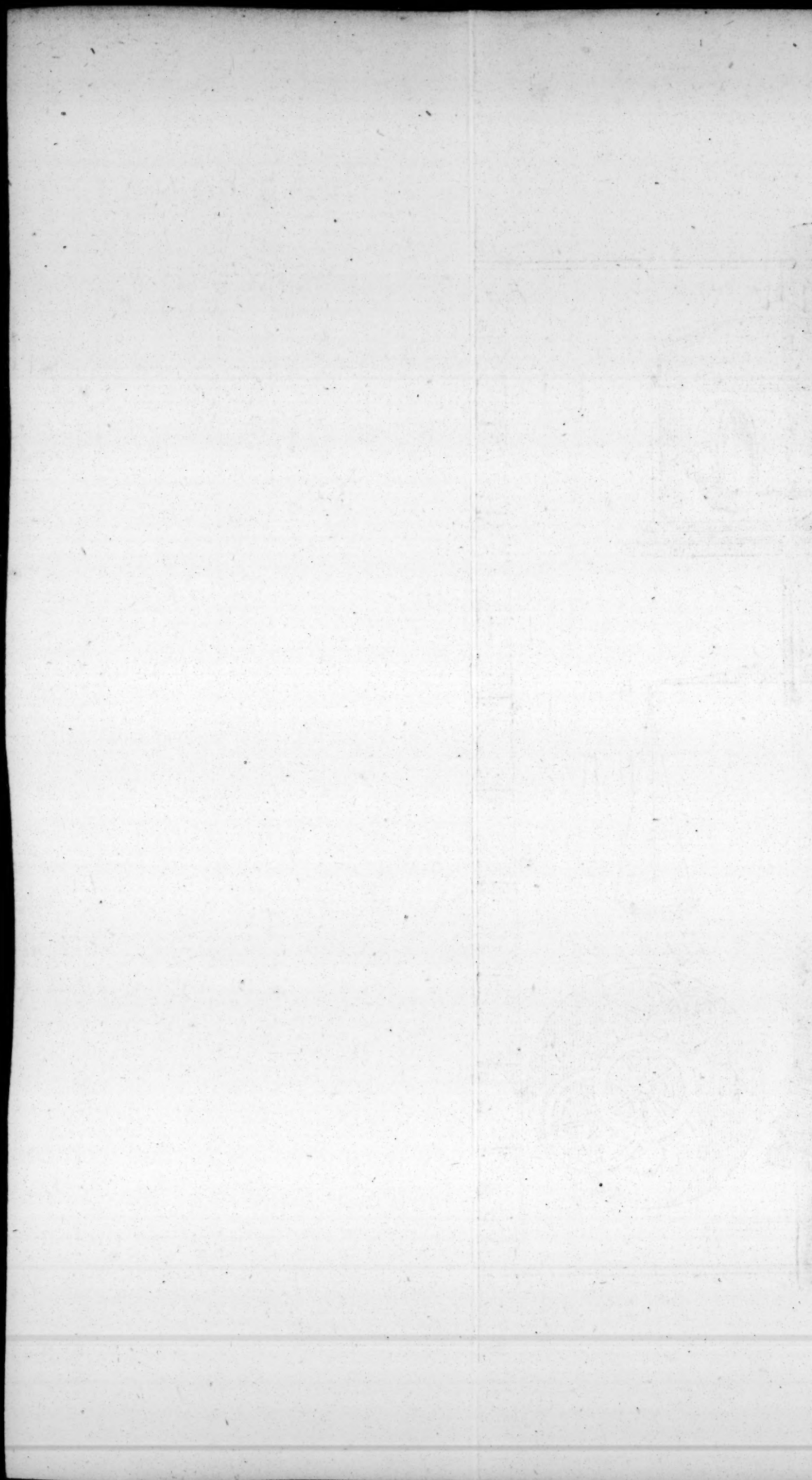


Fig. 1. p 205.

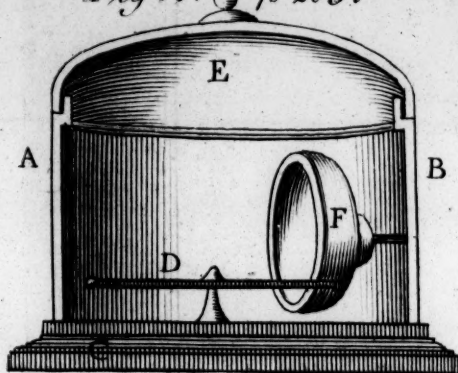


Fig. 5. p 217.



Fig. 2. p 211.



Fig. 4. Q p 213.

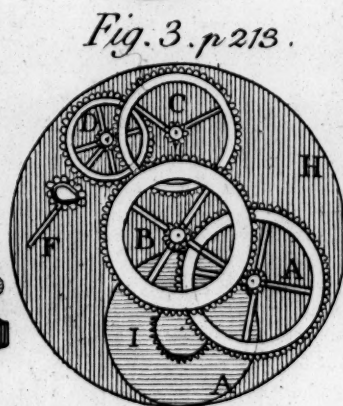
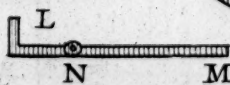
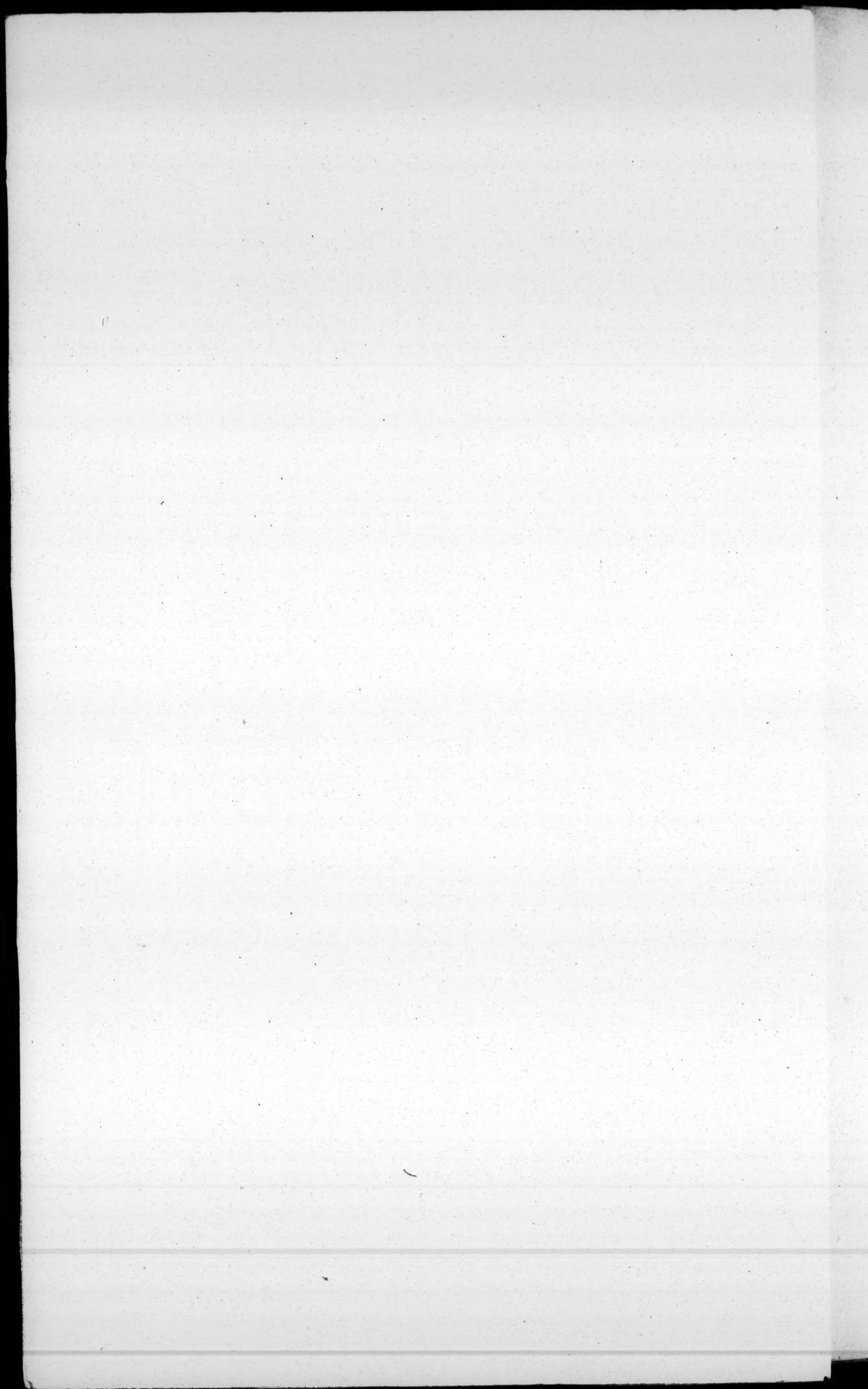


Fig. 3. p 213.





RECREATION LI.

The magician's box.

FIRST construct the base AB, (Plate XVIII. Fig. 1.) of six inches long, four wide and one deep. Let it be hollow, and covered with a piece Q, that slides in a groove. In the middle of the top piece make a hole, either square or round, of about half an inch wide.

On this basis place four planes of glass F, Fig. 2. joined together in the form of a truncated pyramid, and lined with gauze or thin paper. At its bottom IL, it should be two inches and a half square; but at top MN, only one inch and a half. At the opening place a convex glass V, of five inches focus, that is equal to the height of the machine. Let it be fixed to the base A B.

On the inside of the base, and at two inches distance from one of its shortest sides, fix a pivot, on which is to be placed
the

the circle of pasteboard OP, Fig. 3, of four inches diameter, in which must be fixed the touched needle QR. The pasteboard circle must be divided into ten equal parts, as in the figure; which parts are to correspond to the divisions in the foregoing table. In the five divisions 1, 3, 5, 7, 9, are to be drawn the cards there expressed.

On a second circle of pasteboard, that has the same divisions, write in those marked 2, 4, 6, 8, 10, the five names of different states, mentioned in the foregoing table.

As each circle must be previously placed on the base, and changed for every different Recreation, it will be proper to have two boxes, as it would be impolitic to change the circles before the spectators. It would be still much better if the box could be placed in a chest or cabinet, that was fixed against a partition, behind which

which a confederate is placed ; for then, after performing one recreation, the box might be placed in the cabinet, and the confederate, by a private opening in the partition, might take out the circle, and insert another.

It will be easy to conceive, from what has been already said, that when the machine is placed on the magnetic table, at the part S, so that the pivot on which the circle turns is exactly over the point S, the bar in the part of the roller then there will put the needle in a similar direction, and consequently by looking into the machine, the spectator will see the card, letter or word, that is opposite the index in the table of columns.

A per-

A person is to name the state in which is the city whose name is on the cards that have been dealt to another.

On thirty cards write the names of the five following cities ; London, Lisbon, Madrid, Berlin, Vienna. Then shuffle and deal them after the manner explained in page 79, of the first volume.

Then tell the second person to look into the box, and read the name of the state in which is the city whose name is on the cards in the first person's hand. The same is to be done for the four other parties.

To perform this Recreation, nothing more is necessary than to have a circle with the name of the five states ; and that the confederate be instructed in the order that each name is to be brought forward to the eye of the spectator.

To

In recreations of this kind it will be proper to have a hole in the partition, by which the confederate will know when to move the circle, and keep it steady till he who performs the experiment has covered the eye-glass of the box.

RECREATION LII.

The mystical dial.

PROVIDE a board four inches square, and let it be supported at the four corners by feet about one quarter of an inch high, as AB (Plate XVIII. Fig. 4.) On this board draw two concentric circles, and divide them into ten equal parts, in nine of which write one of the numbers from 1 to 9, and in the tenth an o. These numbers must be placed in the same manner as in the figure, and the line AB must divide the divisions marked 1 and 6, into two equal parts. At the center of this dial place a needle of a convenient size.

It is evident from the construction of this dial, that when the person behind the partition places the index of his table against any number in the third column, the needle of this dial, when it is placed over the roller in the magnetic table, will point to the same number.

To shew by the foregoing dial, the numbers that two persons have chose, their sum, or their product.

You must here have the small bag described in p. 140: in the first division of which put the numbers from 1 to 10, and in three other divisions any numbers you please, suppose 3, 7, and 8; that is, all the tickets in each of those three divisions must have the same number. You then offer two different divisions of the bag to two persons, and they each draw one number, suppose 5 and 7, you having previously agreed with your confederate what the numbers are to be.

You

You then ask them whether the index shall point to their numbers successively, their amount, or their product when multiplied together.

If the numbers are to appear singly, the confederate first directs the index of his table to the number 5, which you are to allow him a sufficient time to do. You then place the index on the dial, and turning it about it will stop at that number. You take off the index while your confederate moves the slider, and placing it on again it will then stop at 7.

If the amount of the two numbers be required, the confederate directs his index first to 1 and then to 2, which make 12. If the product be required, he directs the needle, in like manner, first to 3 and then to 5, which make 35.

You must observe to take the needle off the pivot immediately after it stops, be-

Q 2

fore

fore the roller begins to move again : and as the needle will place itself directly in the position of the bar underneath, you must turn it about as soon as you have placed it on the pivot. Attention should be had to this observation in all the experiments with the magnetic needle.

RECREATION LIII.

The magical game of all-fours.

TO perform this Recreation you must have a pasteboard circle, on which there are twelve divisions, on six of which cards are to be painted, and to which six divisions of the roller must be adapted. A pack of cards are to be previously ranged and shuffled, after the manner described in the first volume, p. 78, and when they are dealt, the hands are to be as follows.

Eldest

Eldest		Youngest	
King	} spades	Ace	} spades
Ten		Queen	
Ace clubs		Nine	
Ace diamonds		Ace	} hearts
King	} hearts	Queen	
Knave		Eight	

Turn-up card, knave of spades.

The eldest takes up his cards. Those dealt for the youngest lie on the table. Now the natural way of playing the above cards would be as follows: first, the eldest hand would lead one of his aces, which the youngest would win with his nine of trumps; and then play his ace and queen of hearts, the latter of which the eldest would win with his king: he would next lead his other ace, to which the youngest would play his eight of hearts. The eldest must then lead from his king and ten of trumps, both which the youngest must take with his ace and queen, and consequently have highest, lowest, and game,

Q₃

which,

which with the knave turned up, will make him all-fours,

Therefore when the eldest plays, you say aloud to another person, the gentleman plays the ace of clubs, for example, look in the box and see what card I must play; when your confederate will directly bring the nine of trumps on the circle to view. When it is your turn to play, you have no occasion to say any thing, but only desire the person to look in the box and see what card is played, your confederate having directions what to do. Thus you go on till the eldest has played all his cards. But you must observe, each time the circle is to be moved to prevent the person from immediately looking into the box, by some amusing discourse; or it might be better to stand by the box yourself, in order to cover and uncover it each time the person is to look in, that the circle may have time to settle,

RECREATION LIV.

The intelligent fly.

AT the center of a box about six inches square and one inch deep (Pl. XVIII. Fig. 5.) place a pivot. Have a touched needle L, three inches and a half long, and at the end of it that is touched fix a fly made of enamel; the other end of the needle must be something heavier, to keep it in equilibrio. This needle is to be placed on the pivot.

On a piece of square pasteboard that will just go into the box, draw a circle, ABCD, three inches and a half diameter; and another at a small distance, concentric with the former. The part within the last circle must be cut out. This pasteboard circle is to be placed about half an inch from the bottom of the box, and divided into ten equal parts, in which are to be

Q₄

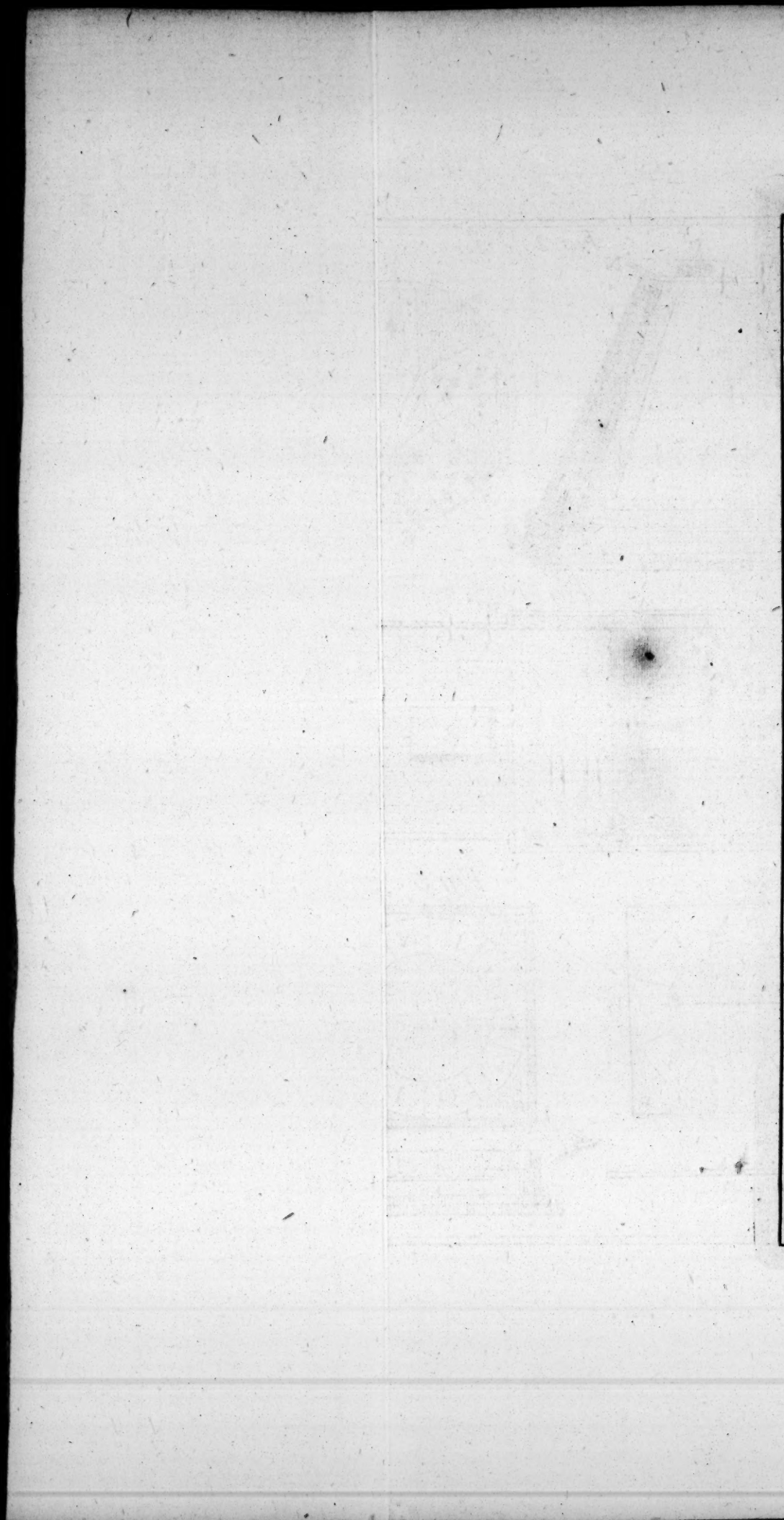
wrote

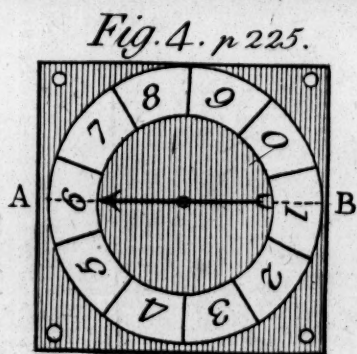
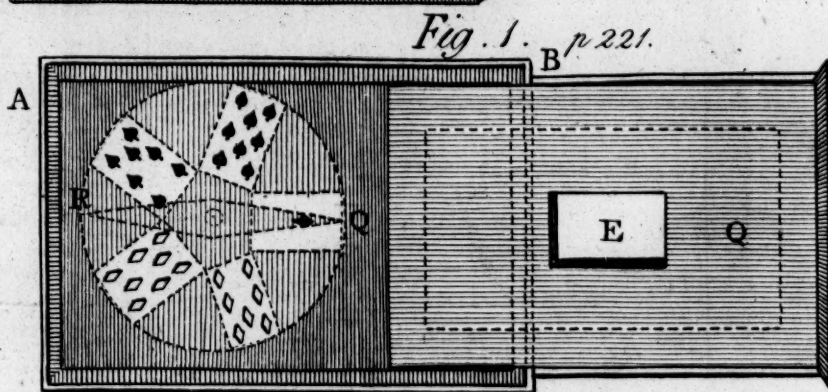
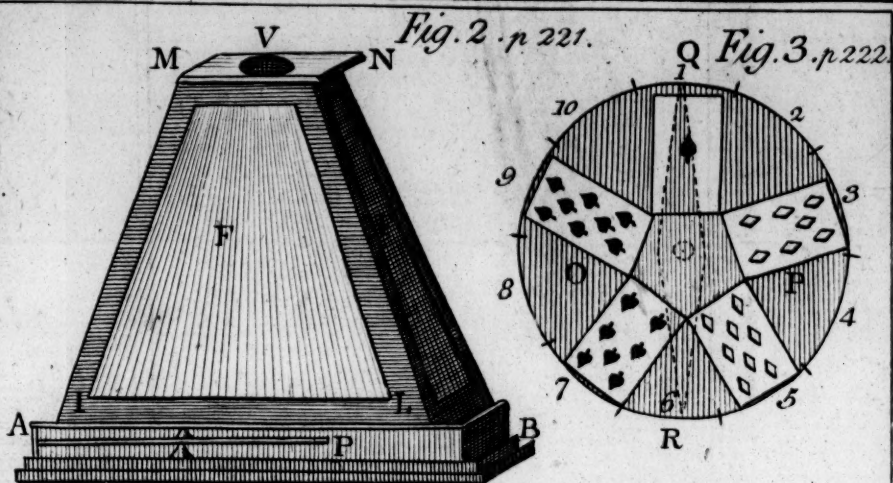
wrote the letters A, E, I, O, U, D, G, L, N, R, as in the figure.

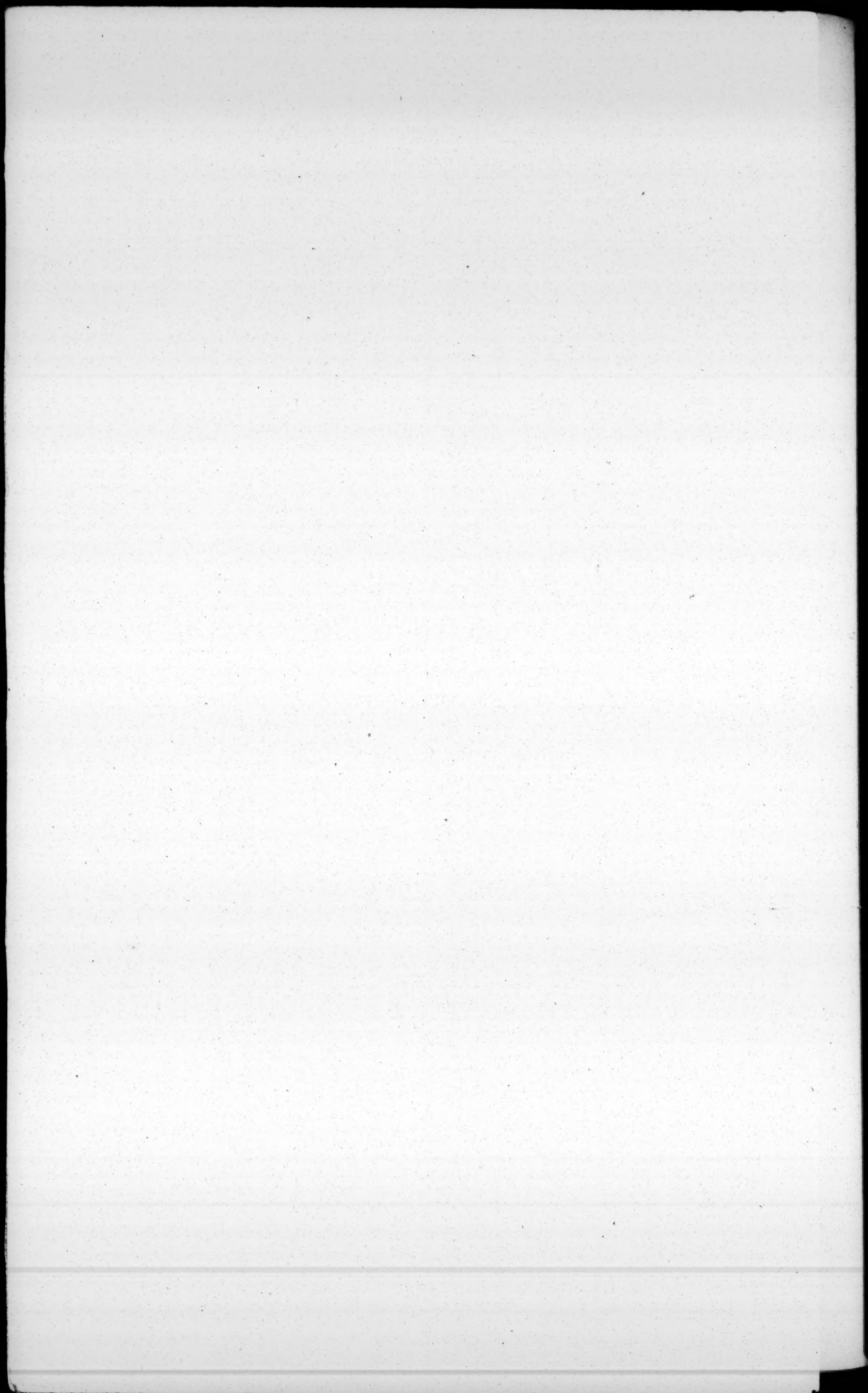
Place a glass about half an inch above the circle, and cover it with a circle of paper C, large enough to hide the needle, and leave only the fly visible: on this paper you may paint some allegoric figures, that its use may not be suspected. You must next write on 24 cards the following questions. These cards are to be packed and shuffled, according to the method explained in the first volume, p. 78, that they may be in the order the questions are here placed.

QUESTIONS.

1. Which is the land of liberty?
2. Which is the first city in the world?
3. Whom do many men despise, though they have not half his merit?
4. Who is the poorest man in the world?
5. Who is the meanest of all mankind?
6. For what do all young women long?
7. Who, by station, is the most







most miserable of all beings? 8. By what does a man discover his weakness? 9. What would every married woman do if she could? 10. In what does a man show his pride and folly? 11. What makes a woman cry more than the loss of her husband? 12. How does a man talk who has nothing to say? 13. What most resembles a fine lady? 14. What frequently reminds us of a great loss, without giving disgust? 15. What makes a young woman in love with an old man? 16. What does the poet want to cover his empty skull? 17. What should a man never take from the woman he loves? 18. What must that man be who would gain the esteem of all? 19. Who is he that seeks a man's company when his money and friends are all gone? 20. What gains the good will of the physician, the lawyer, and the harlot? 21. What do good men revere and knaves abuse? 22. What does a man depend on when he trusts to his friends for support? 23. What

23. What can he be sure of, who leaves his affairs to another? 24. What makes as great a difference almost, if not altogether, between this man and that, as between that and a brute?

After you have ranged the cards in the manner before mentioned, you place them on the table, and ask any person which of them, in the order they then stand, shall contain the question to which the fly shall give him the answer. If he say, for example, the 20th, your confederate, who has the following copy of the answers, will make the needle, at the end of which the fly is, successively point to the letters that compose that word: then counting the cards over till you come to the 20th, you will find that word answer the question.

A N S W E R S.

- | | | |
|---------------|------------|------------|
| 1. England. | 2. London. | 3. A dog. |
| 4. A niggard. | 5. A liar. | 6. A ring. |
| | | 7. A |

RECREATIONS. 235

7. A nun. 8. Anger. 9. Rule. 10. A
duel. 11. An onion. 12. Loud. 13. An
angel. 14. A dial. 15. Gold. 16. A
laurel. 17. A derrial. 18. Generous.
19. A dunn. 20. A guinea. 21. Reli-
gion. 22. A reed. 23. Ruin. 24.
Learning.

Many other Recreations may be per-
formed by this intelligent fly by numbers,
cards, &c. similar to those we have alrea-
dy explained on other occasions, and
which, to avoid the appearance of repeti-
tion, we shall not here describe.

RECRE-

RECREATION LV.

The multifarious verse.

THE eight words that compose this Latin verse,

Tot sunt tibi dotes quot cæli sidera virgo 1.*

being privately placed in any one of the different combinations, of which they are susceptible, and which are 40,320 in number, to tell the order in which they are placed.

Provide a box that shuts with hinges, and is eight inches long, three wide, and half an inch deep (Plate XIX. Fig. 1.) Have eight pieces of wood about one-third of an inch thick, two inches long, and one and a half wide, which will therefore when placed close together, exactly fill

* Thy virtues, virgin, are as numerous as the stars of heaven.

the box. In each of these pieces or tablets place a magnetic bar, with their poles as is expressed in the figure. The bars being covered over, write on each of the tablets, in the order they then stand, one of the words of the foregoing Latin verse.

On a very thin board of the same dimension with the box, Fig. 2, draw the eight circles, A, B, C, D, E, F, G, H, whose centers should be exactly over those of the eight tablets in the box, when the board is placed upon it. Divide each of those circles into eight parts, as in the figure, and in each of those divisions write one of the words of the Latin verse, and in the precise order expressed in the plate, so that when the board is placed over the box, the eight touched needles placed at the center of the circles may be regulated by the poles of the bars in the box, and consequently the word that the needle points to in the circle be the same with that inscribed on the tablet. Cover the board
with

with a glafs to prevent the needles from rifing off their pivots, as is done in the fea-compafs.

Over the board place four plates of glafs, I, L, M, N, Fig. 3, which will give the machine the figure of a truncated pyramid, of eight inches high. Cover it with a glafs, or rather a board in which are placed two lenfes O, of eight inches focus, and diftant from each other about half an inch. Line the four plates of glafs that compofe the fides with very thin paper, that will admit the light, and at the fame time prevent the company from feeing the circles on the board.

Thefe preparations being made, you give the box to any one, and tell him to place the tablets on which the words are wrote privately, in what pofition he thinks proper, then to clofe the box, and if he please, to wrap it up in paper, feal it, and give it you. Then placing the board with
the

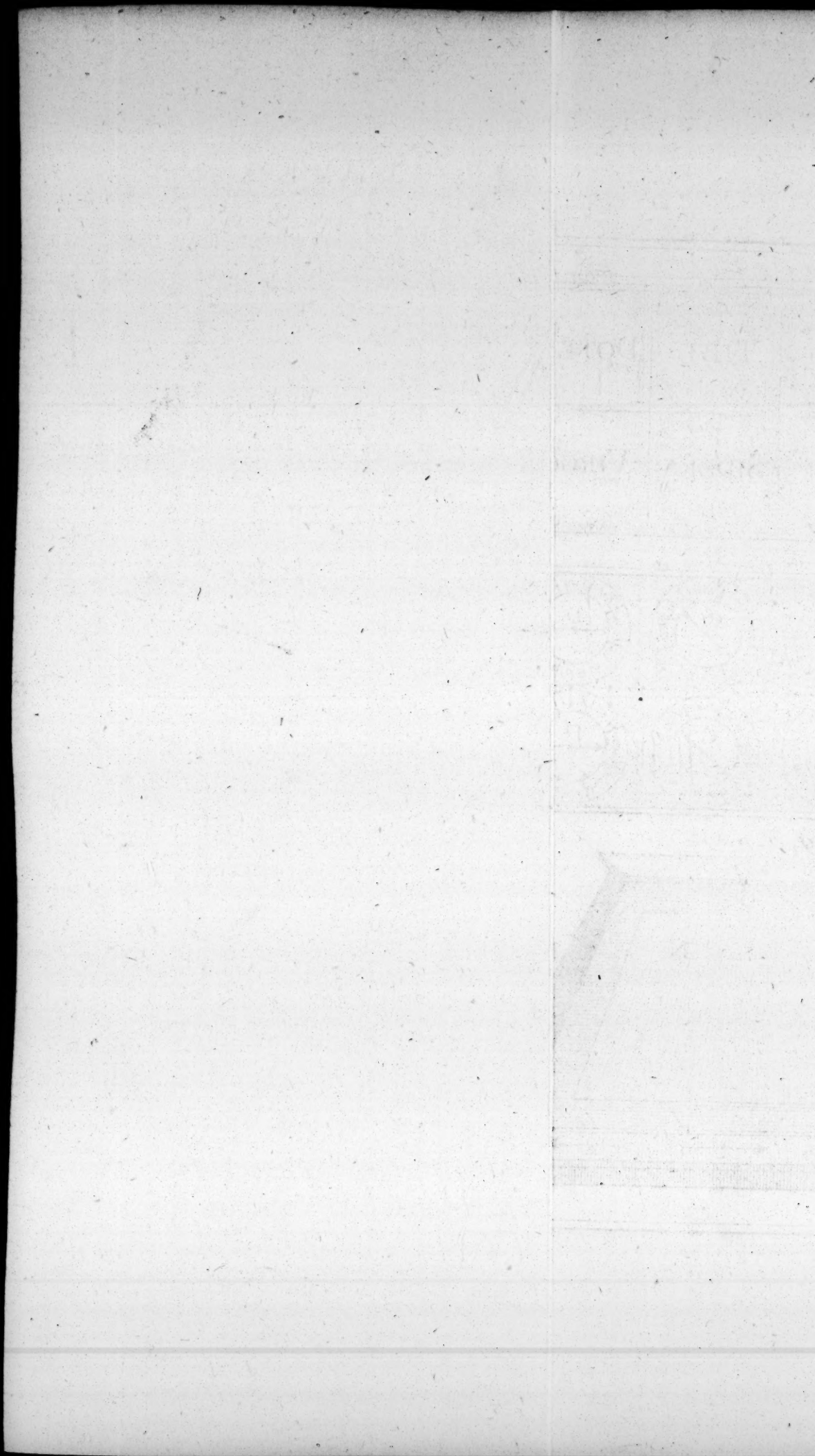


Fig. 1. p. 236.

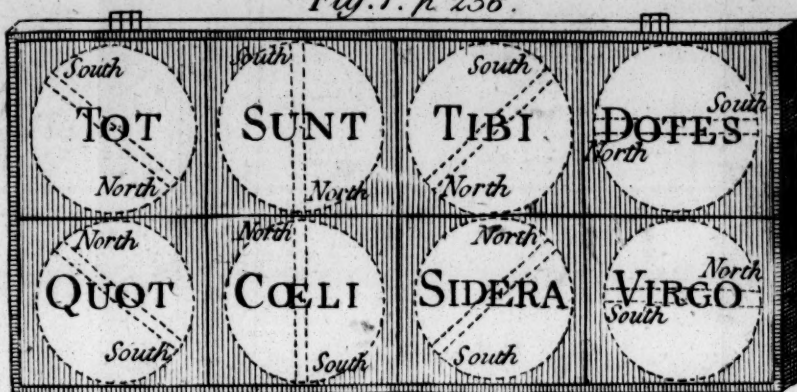


Fig. 2. p. 237.

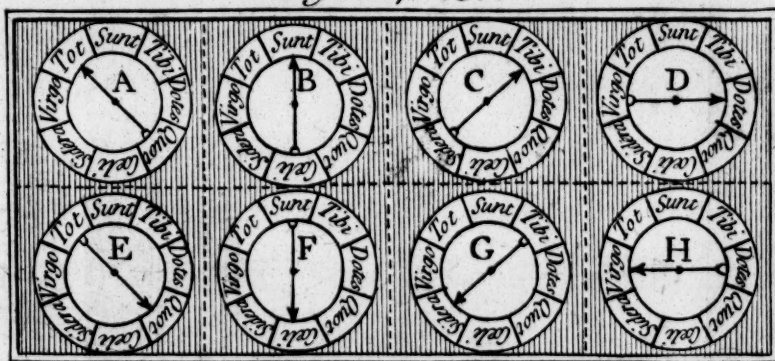
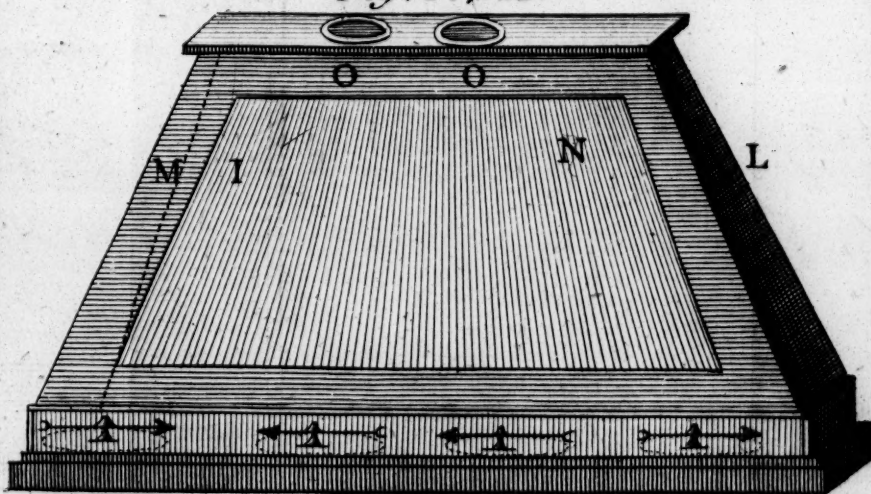
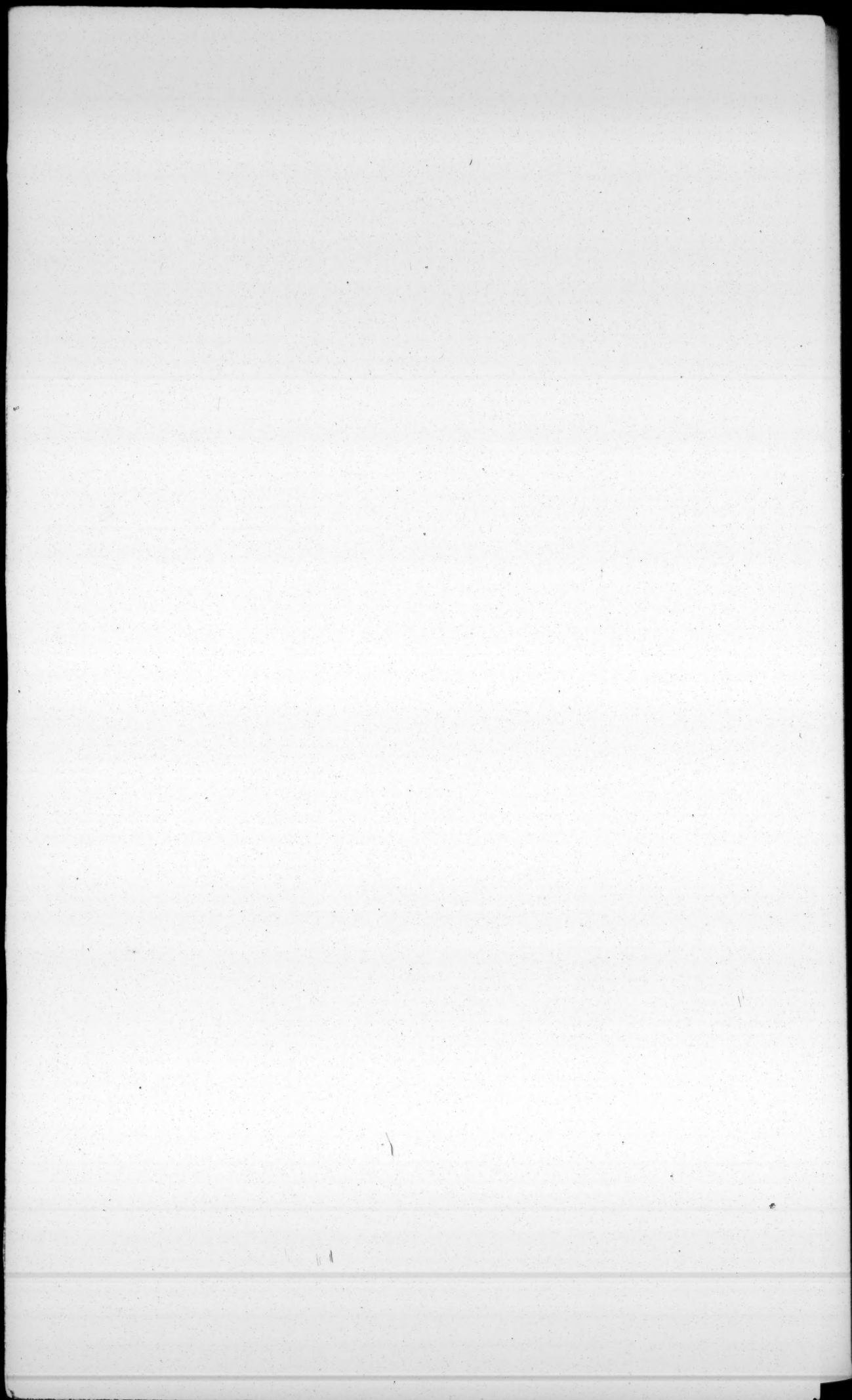


Fig. 3. p. 238.





the pyramid upon it, you immediately tell him the order in which the tablets are placed, by reading the words to which the needles on the circles point.

This Recreation, which appears to have been invented by M. Guyot, is of the same nature with that of the box of numbers, that has been frequently exhibited, but much more entertaining. For here there is not only a vast number of combinations to be formed, but the words at the same time constantly preserve one meaning. If the first inventors of this sort of Recreation had made use of words in this manner, instead of numbers, the investigation would have been attended with much more difficulty.

RECREATION LVI.

The communicative mirror.

LET there be made a box AB, (Plate XX. Fig. 1.) the top of which draws off at the end A. Let it be on the inside nine inches long, six wide, and two-thirds of an inch deep. At the bottom of this box, and at three inches distance from the end A, fix a pivot, on which is to be placed the circle of pasteboard M, Fig. 2, that contains a touched needle. Divide this circle into four equal parts, in three of which paint three cards, in the position expressed in the figure.

In the top of the box make a hole an inch and a half in diameter, over which place the pedestal CD, composed of four plates of glass, covered on the inside with very thin paper.

On the top of the pedestal place the tube EF, about six inches long, and one and a half in diameter. In this tube at M, is to be fixed an inclined mirror, by which the part of the pasteboard circle under the hole at L, may be seen by the eye at G. At the end F of the tube place an eye glass, whose focus is equal to the distance G M: and at the end E, any glass you please. At the end B of the box, place the mirror T V, which serves to make the spectator think it is in that he sees the card on the pasteboard.

In the box A B C D, Fig. 3, that shuts with hinges, and is of the same dimension with the inside of the other box, are to be placed successively the three tablets X, Y, Z, in one determinate position. In each of these tablets must be fixed a magnetic bar, in the manner expressed in the figure, and on each of them is to be pasted one of the same cards with those on the pasteboard.

circle. One of these tablets as for example, that marked Z, being placed in the box, in the manner expressed in the third figure, the needle on the circle will place itself in a corresponding position, and the similar card on the circle will come under the pedestal. You therefore present the box, Fig. 3, and the three tablets, to a person, desiring him to place any one of them he thinks proper, in the box, privately ; then to conceal the others, and after he has closed the box, to return it you. Then placing the first box, with the pedestal, tube, and mirror over the other, you direct him to look in the seeming perspective-glass, when he will see the figure of the card he placed in the box, and it will appear to him to be in the mirror TV.

You may have a fourth tablet, that contains a bar, but on which there is nothing painted. This tablet you may place first
in

in the box, and let the party see that when there is no card in the box he cannot see any in the perspective.

RECREATION LVII.

The box of dice by reflection.

LET there be a small box of wood, ABCD, (Plate XX. Fig. 4.) ten inches long, two wide, and one and a half high. At the two ends of this box fix the two hollow cubes I, L, one inch and a half square, in which are to be placed two dice exactly of the same dimension.

The ends A C and B D of the box are to have sliders that draw up, in the manner expressed by Fig. 5. There must be likewise at each end a small panel M, that may be raised or depressed one-tenth of an inch, by which

R 2

a small

a small hole at N may be covered or uncovered; and through this hole you are to see into the box.

The top and two longest sides of the box are to be of glass, lined with a thin paper. Within the box are to be placed two mirrors OP and QR, at an angle of forty-five degrees, by which, when you look through the holes at the two ends of the box, you will easily see the bottoms of the two cubes I, L, that are placed on it.

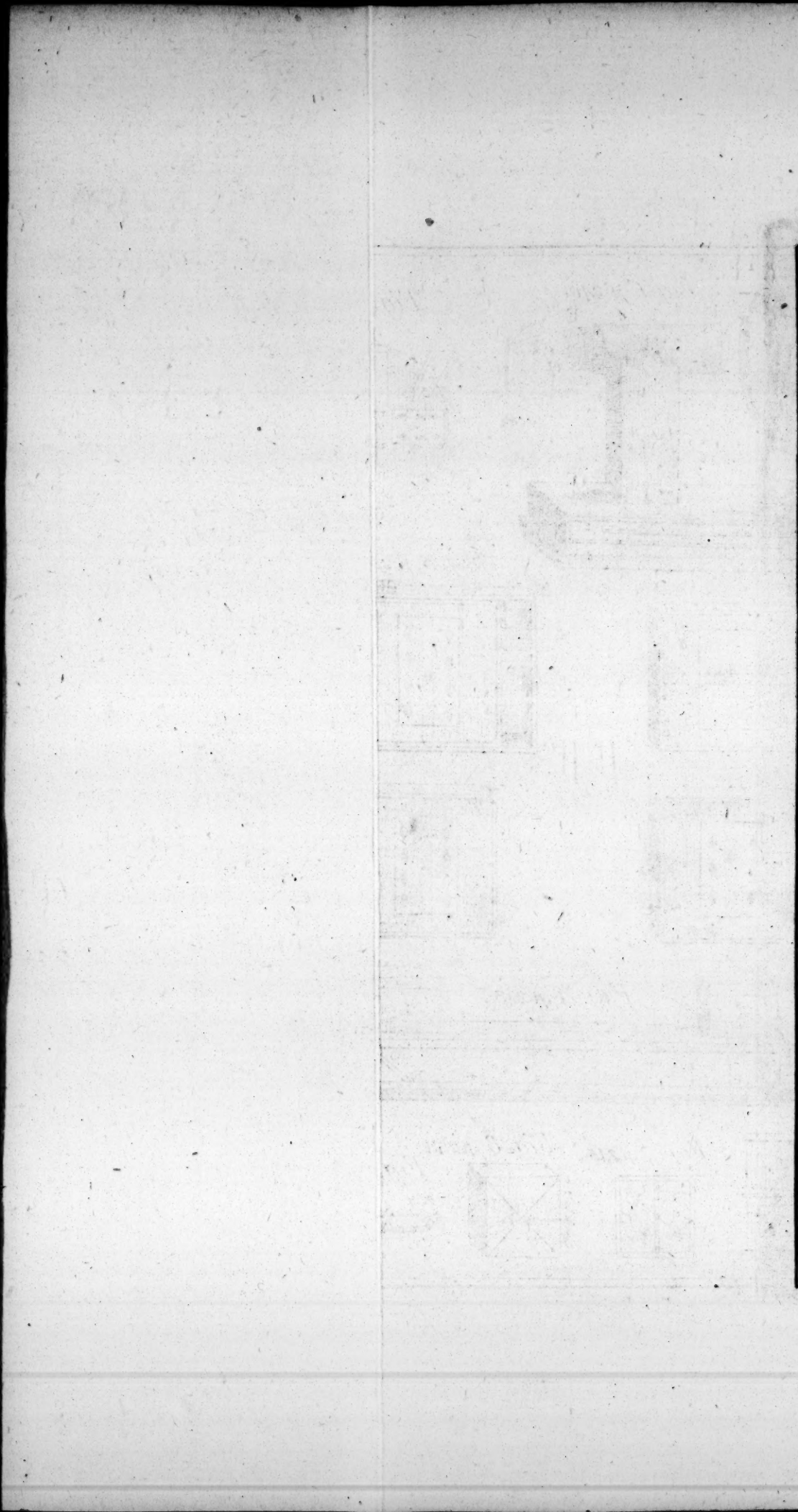
Divide the bottoms of the cubes just mentioned into four equal parts, by diagonals drawn from the opposite angles, as in Fig. 8, and again divide that side next the middle of the box into six equal parts, which are to correspond to the six points that are on a die.

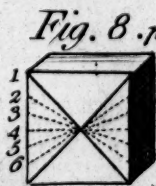
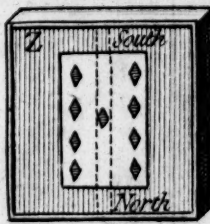
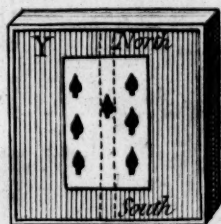
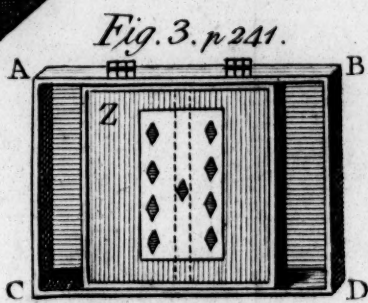
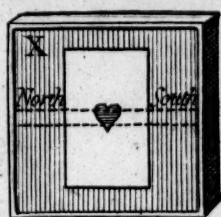
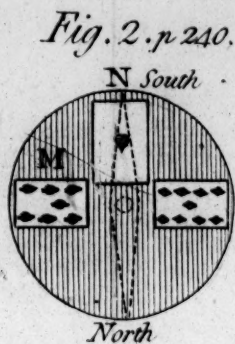
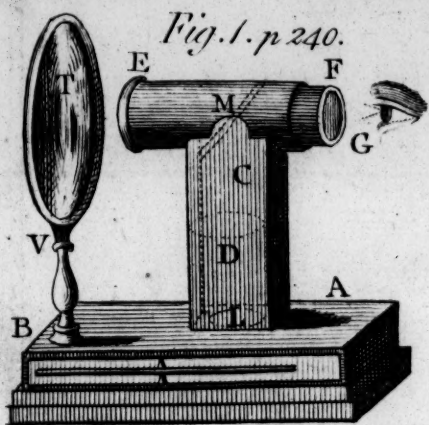
Under each of the cubes place a small brass stand A B, Fig. 6, which is to be disposed

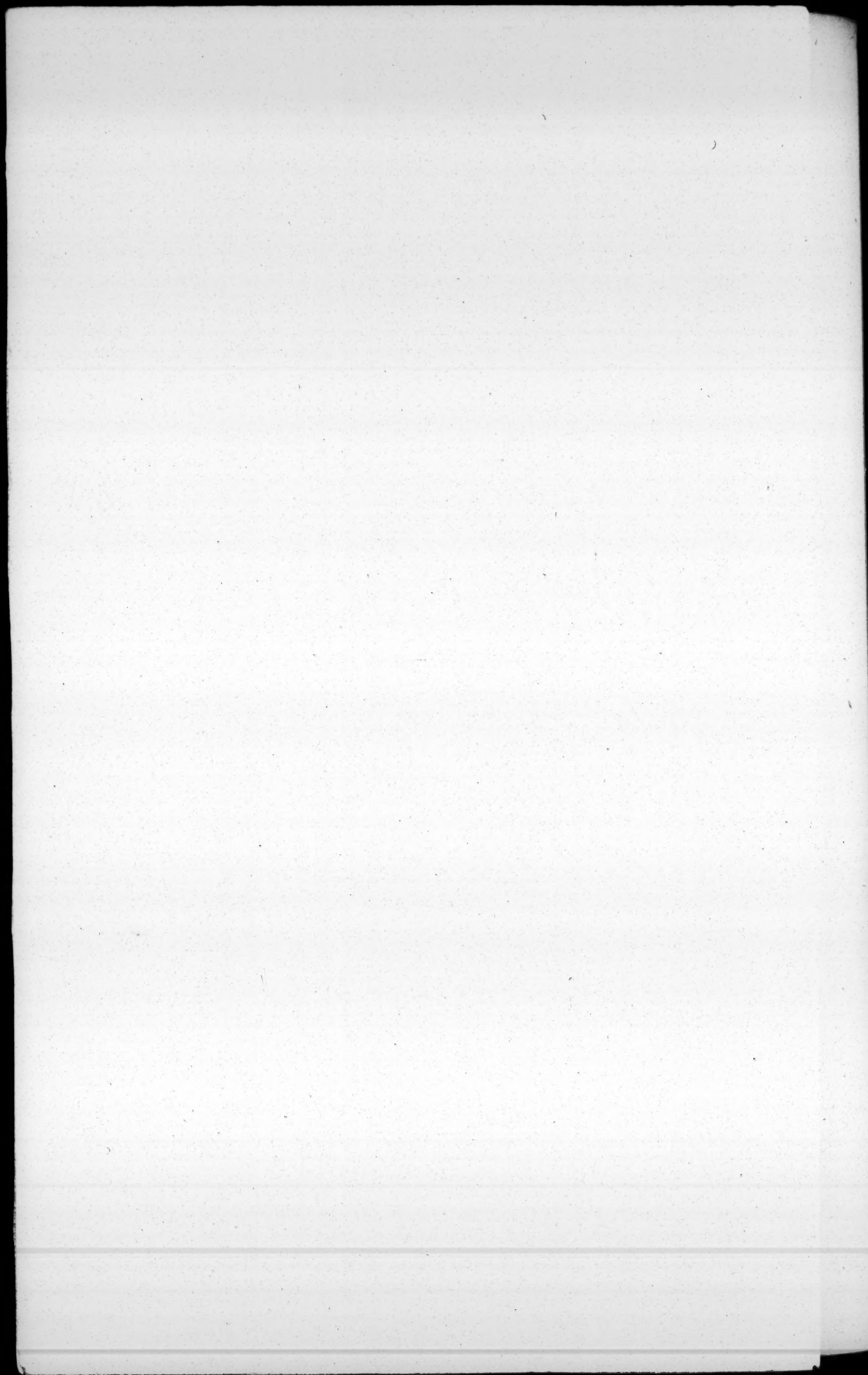
disposed as in Fig. 7. On the stand there must be a pivot, directly under the center of the cube, and it must hold two needles, one of brass and the other of steel, and touched. These needles are to be placed at right angles to each other, as in the figure.

Divide each face of a die into four equal parts, by diagonals from the opposite angles, and then divide each side into six equal parts, and in each side of the die, opposite to one of those parts, each different from the other, place a magnetic bar one inch and a quarter long, two-tenths of an inch wide, and one tenth thick. All the divisions on these dice must be very exact: cover them with double papers, and write on each side of them the points it is to express, when its opposite side is next to the touched needle: they are then to be placed in the two hollow cubes, which are to be covered.

This machine being constructed with care, according to the foregoing directions, you present the two dice to any person, and desire him to place them privately in the two cubes, in what position he please, and put on their covers. Then looking through the two holes, you immediately tell him, by the direction of the needles to the under sides of the cubes, the exact number of points they compose.







THE
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ELECTRICAL RECREATIONS.

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RECREATION I. p. 46

The animated feather.

A feather being brought near an excited tube is first attracted by it and then repelled, and the tube cannot be brought close

C O N T E N T S. 249

close to the feather, till it has touched some other body.

R E C R E A T I O N II. p. 48

The self-raising pyramid.

A large bundle of threads being suspended from the electric branch, (Plate III. Fig. 3.) will rise up in form of a pyramid, and continue so as long as the wheel is turned, but when that ceases the threads will resume their first position.

R E C R E A T I O N III. p. 49

The magical dance.

Three bells are suspended from the electric branch, and between them hang two brass knobs. The bells being electrified will attract the clappers, and be struck by them, and the ringing will continue as long as the machine is in motion. This is the music for the dance. A plate is then suspended from the
4 branch,

branch, and on a metal stand, placed under it, are put the figures of men, which being attracted by the plate will be in continual motion. This Recreation may be suspended or renewed at pleasure.

RECREATION. IV. p. 52

The artificial spider.

The body of this spider is of cork, and its legs of linen thread. When it is held, by a fine line of silk, between the electric branch and an excited stick of wax, it will appear to be animated, continually jumping from one to the other.

RECREATION V. p. 53

The marvellous fountain.

A vessel of water, in which a syphon is placed, being suspended from the branch, as soon as it is electrified the water will begin to flow, and when the electrification

C O N T E N T S. 251

tion is strong, several streams will issue in form of a cone. This experiment may be diversified by using a fountain made with condensed air.

R E C R E A T I O N VI. P. 54

The magic picture.

This picture or print must have a frame and glass. The border of the print is cut off, all round: the upper and under part of the middle of the glass is covered with tin-foil, that communicates by the bottom of the frame: over this tin-foil the print is pasted. When the picture is a portrait a crown is placed on its head, which a stranger attempting to take off, at the same time he holds the frame by the bottom, receives a smart shock, and fails in the attempt.

R E C R E -

RECREATION VII. p. 56

The Tantalian cup.

A metal cup is placed on a stool of baked wood, and a chain from the branch is fixed to the cup. A person endeavouring to taste the liquor in the cup, receives a shock. The machine being stopped, another person drinks out of the cup with ease: the machine being again put in motion, the first person again attempts to taste the liquor, and receives a second shock.

RECREATION VIII. p. 58

The circular chimes.

A round board is fixed to a perpendicular axis, and several glass radii issue from the board, and to the end of each of them is fixed a brass thimble. Two wires that are joined to the hooks of the electric table, (Pl. III.) and which are dif-

C O N T E N T S. 253

differently electrified, put the wheel in motion, by being properly applied to the thimbles, and the motion increases till it goes fifteen times round in a minute. Two semicircular stands, that holds several bells, being then brought near the wheel, they are alternately and incessantly struck by a radius fixed to the upper part of the axis. This wheel is sometimes used as a jack for roasting meat. p. 60 (note)

R E C R E A T I O N IX. p. 62

The self-moving wheel.

This wheel is constructed on the same principle as the foregoing. A circular plate of glass, gilt on both sides, is fixed to a perpendicular axis : on the edge of this wheel are fixed two bullets, one communicating with the upper surface, and the other with the under surface ; twelve small pillars of glass, with a thimble on the top of each of them, are

are fixed in a circular stand, round the wheel. When this wheel is well charged, the bullets on its edge being differently electrified, attract and repel the thimbles alternately, and thereby give the wheel a motion that increases continually, till it goes more than 20 turns in a minute, and the motion will continue half an hour. The celerity of this wheel may be increased by an additional number of bullets.

RECREATION X. p. 65

The magician's chace.

A wire is placed perpendicular to the branch, and on the top of it turn several horizontal wires, the points of which are bent in opposite directions, and on them are fixed the figures of men, horses, hounds, &c. When these wires are electrified they will turn swiftly round, and the figures will seem to pursue each other. This Recreation may be improved by another set of wires,
placed

C O N T E N T S. 255

placed over the former : or by giving the figures a progressive as well as a circular motion.

R E C R E A T I O N XI. p. 67

The planetarium.

Six concentric hoops of metal are suspended from the branch ; under and near to them is placed a metal plate, on which are put glass bubbles, between the hoops : these bubbles correspond to the planets, the hoops to their orbits, and a ball hung over the center of the hoops represents the sun. When the hoops are electrified the balls will move round them, and the motion will continue as long as the operator thinks fit.

R E C R E A T I O N XII. p. 69

The incendiaries.

A person standing on a cake of wax holds a chain that is connected with the branch, and putting his finger into a
5 dish

dish containing spirit of wine, it will be immediately in a blaze; and if a wick that communicates with the spirit be laid to a train of gunpowder, it may blow up a magazine, or set fire to a city. This experiment may be diversified by making the electricity pass through several persons that touch each other.

RECREATION XIII. p. 72

The inconceivable shock.

A person holding a chain that is joined to one of the hooks of the electric table, attempts to fix a wire on the other hook, when he instantly receives a shock through the body, without knowing from whence it proceeds. This Recreation may be diversified by concealing the chain under a carpet on which a person treads, and by laying a wire that communicates with the other hook, in such manner that he may acciden-

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cidentally take hold of it. Methods of communicating the shock to a great number of persons at the same time

P. 73

R E C R E A T I O N XIV. p. 75

Magical explosions.

Gunpowder is made up in the form of a small cartridge, in each end of which is put a blunt wire; the ends of these wires within the cartridge are about half an inch distant. Two chains, that communicate with the two hooks in the electric table, being joined to the external ends of the wires, the electric fire will pass through the cartridge, with an instant explosion. By a similar method brass or iron wire may be melted.

R E C R E A T I O N XV. p. 78

Prismatic colours.

A tin plate is placed between two wires that communicate with the two hooks

of the electric table, and after many explosions three distinct rings appear, each of which contains all the colours of the prism or rainbow. This experiment corroborates the Newtonian doctrine of colours. p. 78 (note)

RECREATION XVI. p. 81

The artificial earthquake.

An edifice, composed of several loose pieces, is placed on a board in the middle of a large basin of water. A wire that communicates with the hooks in the table, being laid over the board and the surface of the water, they become greatly agitated by the explosion, and the edifice is laid in ruins.

RECREATION XVII. p. 82

The electrical kite.

The kite consists of a large thin silk handkerchief, whose corners are fastened to the

the ends of two slips of cedar, and to the top of the upright piece is fixed a pointed wire, about a foot long: the other parts are the same as in a common kite. To the end of the twine next the hand a silk ribband is tied, and where the twine and ribband join a key is hung. This kite is raised when thunder is approaching. The electricity is conducted from the wire of the kite to the twine, and from that to the key, by which a phial may be charged and all the common experiments in electricity performed. Account of some very extraordinary phenomena that were produced by an electric kite in the south of France

p. 83

Description of an apparatus for drawing the electric fire from the clouds without danger.

p. 89

RECREATIONS IN THE DARK CHAMBER.

RECREATION XVIII. p. 91

The miraculous luminaries.

Method of making the phosphorus proper for this Recreation. The figure of the moon and stars being drawn on a board, a quantity of the phosphorus is fixed over them, and a number of phials are discharged on the phosphorus, by which the figures are strongly illuminated. The board is then placed against the ceiling, and the luminaries appear as shining in the zenith,

RECREATION XIX. p. 94

The globular fires.

These fires are produced by the globe and cushion only, without the conductor. The globe being strongly excited, parts of circles of fire will appear on both sides
the

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the rubber, and sometimes completely surround the globe. If a finger be brought near the globe, when it is in that state, there will frequently be a complete arch of fire from the finger to the rubbers though it be almost on the opposite side of the globe. If the air be exhausted from the globe, the electricity will all appear on the inside, p. 96

R E C R E A T I O N XX. p. 96

The luminous shower.

On a metal plate set under the branch is put a quantity of brass dust, and over it another plate is suspended from the branch, and when it is strongly excited the dust will be attracted and repelled with great rapidity, and exhibit the appearance of a luminous shower. A similar phenomenon by a sponge filled with water, p. 97

RECREATION XXI. p. 97

The illuminated vacuum.

A wire is cemented in the top of a large exhausted receiver, and the upper end of the wire is brought to the conductor, when one or more streams of light that reach the whole length of the receiver, appear in a beautiful manner. The appearance of this light remarkably different, according as the vessel is electrified positively or negatively p. 98

RECREATION XXII. p. 100

The luminous cylinder.

A brass plate is fixed at the bottom of an exhausted receiver, and another plate is contrived to let down, near the former. The electricity passes from one to the other of the plates, the whole length of the vessel, and appears as a corrosion of a bright silver hue.

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RECREATION XXIII. p. 101

The magical constellations.

On a board are marked a number of spots, at different distances, so as to correspond with the stars in two or more contiguous constellations. On the sides of each spot are made two holes, in which wires are placed, that nearly meet over the spot. The other ends of the wires communicate with the branch, and when that is electrified all the stars appear luminous, and shine with unfading lustre as long as the machine is in motion.

RECREATION XXIV. p. 103

The luminous characters.

Several rows of tin-foil, that all communicate, are placed on a board, at equal distances (Plate IV. Fig. 1.) From
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these rows the characters are cut out. One end of the tin-foil being brought to the conductor, the electric fire would pass over the whole imperceptibly, but being stopped by the breaks in the lines it jumps from one to the other, and all the characters become luminous, and remain so as long as the operator thinks fit.

R E C R E A T I O N XXV. p. 105

Prismatic illumination.

An exhausted cylinder is fixed to a lath, and is rubbed by the hand as it turns, when a body of light variegated with all the colours of a prism, appears in the glass, and these colours are continually changing. When a little air is let into the cylinder the colours are more vivid: when more air is admitted there are continual corruscations, with the appearance of a cascade of fire, trees, moss, &c.

RECREATION XXVI. p. 108

The aurora borealis.

A Torricellian vacuum is made in a glass tube, one end of which is applied to the conductor, and the other end held in the hand; the whole tube then appears to be filled with light, which continues for a considerable time; after this light disappears, if the tube be drawn through the hand, a very intense light is seen, and reaches, without interruption, from one hand to the other.

RECREATION XXVII. p. 110

The circulating lamps.

To the upper axis of the self-moving wheel are fixed several radii, and from the end of each of them hangs a lamp, filled with spirit, and that of each lamp
is

is tinged with a different colour. The wheel having acquired a considerable velocity is placed under the branch, from which hangs a chain, that as the wheel turns round dips into the spirit of each lamp and sets it on fire. These lamps being all of different colours, and revolving in a quick succession, produce a pleasing effect.

MAGNETISM.

DEFINITIONS	- - -	p. 113
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Nature of the magnetic attraction, aph. 1 to 6,—Properties of the magnetic needle, aph. 8 to 10.—Strength of the natural magnets, aph. 10 and 11.—Magnetic quality of iron, aph. 13 and 14.—Methods of communicating and destroying magnetism, aph. 15 to 17.

Method of making artificial magnets 122

The magnetic perspective-glass 128

The magnetic wand 131

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RECREATION XXVIII. p. 133

The communicative crown.

A large sewing needle, that is strongly touched, is concealed in a crown piece. You desire a person to lend you a piece of the same sort, which you change for the other, and giving that to the person, you discover whether it be enclosed in a snuff-box, or not, by holding the magnetic perspective over the box.

RECREATION XXIX. p. 135

The magnetic table.

A magnet is concealed under a table, and is moveable by a pin, at one end of it. Small nails are laid on that part of the table where the magnet then is, and they are attracted by a key you hold over them. You change the position of the magnet, by the pin, and give the key to any one, when it will not attract

attract the nails. You change the position of the magnet a second time, and giving the key to another person, it will immediately attract the nails.

RECREATION XXX. p. 136

The mysterious watch.

You ask any one to lend you his watch, and placing it over that part of the table mentioned in the last Recreation, where the magnet is, it will presently stop. You change the position of the magnet, and desire the person to lay his watch in the same place, when it will not stop. You move the magnet a second time, and giving the watch to another person, it will stop as before.

RECREATION XXXI. p. 137

The bouquet.

A small box of thin wood (Pl. VII. Fig. 1.) is contrived to contain two artificial flowers;

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flowers : the principal stalk of each of them is strongly touched, but in different directions. By holding the magnetic perspective over the box you discover which of the flowers is concealed in it.

RECREATION XXXII. p. 139.

The magnetic dial.

A magnetic needle is concealed in a hollow circle, (Plate VII. Fig. 2.) and opposite its north end a pin is fixed in the border of the circle ; over the needle is placed a dial, that moves freely in the hollow circle, and on which are numbers, &c. A person draws a ticket from a bag, in which there are several divisions, and then turning the hand of the dial about it stops at the number he has drawn ; you having previously set the north end of the magnet, by the pin in the circle, to that number on the dial.

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RECREATION XXXIII. p. 143

The magnetical cards.

This Recreation is similar to the last, but here instead of the numbers of the hours, one of each of the four suits of the cards, are drawn, and the eight names of the cards of piquet are wrote (Plate VII. Fig. 4.) you offer a piquet pack to a person that he may draw a card, taking care that he draws the long card, as is explained in the first volume. He then turns the needle round, and it stops at the card he drew : you having previously placed the magnet against that card. This Recreation may be diversified by having two needles, and letting two persons draw each a different long card.

RECREATION XXXIV. p. 147

The dextrous painter.

There are two small boxes and four small boards, (Plate VII. Fig. 1.) on which different subjects are painted, and in each of which a magnet is concealed. There is likewise a small circle of pasteboard, Fig. 2, on which are drawn the same subjects as on the boards: this circle turns on a pivot, and contains a magnet. A person places any one of the four boards in one of the boxes privately, and you place the other box, with the pasteboard circle over it; when the magnet in the board will turn the circle, till that part of it which is under an opening made in the top of the box, present the same picture as that on the board, and which is supposed to be drawn by a little painter concealed in the box.

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RECREATION XXXV. p. 150

The cylindric oracle.

In the side of a hollow cylinder (Plate IX. Fig. 1.) is concealed a magnetic bar: on its cover is a circle, with numbers, and at the center of that circle is a pivot, on which a magnetic needle turns. A person draws a question out of one of the divisions of a bag, and turning the needle at the top of the cylinder it stops at the number with which the answer contained in the cylinder is marked; you having placed that number over the magnetic bar when you put the cover on the cylinder. Example of the different answers that may be given to the same questions, p. 152.

RECREATION XXXVI. p. 153

The mystical dial.

There is to be a small box (Plate IX. Fig. 2.) and four boards, Fig. 3; in each of these boards a magnet is placed, in a different position, and on it a different number is wrote. A person is to place one of the boards in the box, and to choose whether the needle of the dial, Fig. 4. when placed over the box, shall point to the whole, the half, the double, or triple of the number on the board; and you then place the dial on the box in a determinate position.

RECREATION XXXVII. p. 156

The enchanted ewer.

A hollow cone is placed in a ewer (Plate X. Fig. 1.) at the bottom of which is a
VOL. III. T hole

hole: under that hole a convex mirror, and between the hole and the mirror is a pasteboard circle, Fig. 3, that turns on a pivot. The ewer is placed on a stand, Fig. 1, in which is a drawer. The pasteboard circle is divided into four parts, in three of which are painted the same figures as on three of the boards, Fig. 5, and the fourth is left blank: this pasteboard circle contains a magnetic needle, and the four boards have each a concealed magnet; therefore when one of them is put in the drawer under the ewer, the circle will correspond to the position of that magnet, and a person looking into the top of the ewer will see his own face surrounded with the head dress of the figure in the drawer.

RECREATION XXXVIII. p. 159

The magician's circles.

There are two hollow squares that are connected by a cross piece which is also hollow (Plate X. Fig. 5.) On each of the squares is a dial, with a moveable hand, and within the squares and cross piece is a movement, so contrived that when the hand of one of the dials is moved, that of the other shall place itself in a determinate position. On these dials are to be wrote certain words, taken from tables constructed for the purpose, and when the hand of one dial is placed to a certain number of words in succession, that of the other directs itself to words which compose the answer. Method of varying this Recreation, p. 164.

RECREATION XXXIX. p. 164

The box and dice.

At one end of a long hollow case or pedestal (Plate XI. Fig. 1.) is drawn a circle divided into twenty equal parts, in which are marked the points that can be thrown by two dice. At the center of this circle is placed a magnetic needle, which is directed by a bar underneath it. At the other end of this pedestal is a vase that has different divisions, in which dice are placed, that seem to be those thrown in at the top of the vase. When the needle is turned round it will stop at those points in the circle that answer to those on the dice in the vase: the bar underneath the circle having been previously set to those points.

R E C R E A T I O N XL. p. 168

The box of flowers.

There are two cases, (Pl. XI. Fig. 3 and 4.) in each of which two flowers are placed, and in each of them is concealed a magnetic bar, fixed in a certain direction: these cases are put in a box of very thin wood, Fig. 2, and when the magnetic perspective is held over them, it is readily discovered, by the direction of the needle, what flower is in that part of the box.

R E C R E A T I O N XLI. p. 170

The box of metals.

At the bottom of a box whose cover is as thin as possible, (Pl. XII. Fig. 1.) are six holes, exactly similar, and in these holes are placed tablets, that each of them contain a magnet, in a different
T 3 position

position, and that is covered with a thin plate of different metal. There is a magnetic perspective, Fig. 2, that has two circles marked with the letters of the different metals, and from its center is drawn an index. If this perspective be held over any one of the tablets, in such manner that its index is perpendicular to the side of the box, the needle in the perspective will point to the letter of the metal over which it then is. This box of metals is far preferable to those formerly exhibited, p. 173.

R E C R E A T I O N XLII. p. 174

The magnetic oracle.

There are eight tablets that each contain a magnet, in a different position; there is also a dial marked with the digits from 1 to 8, (Pl. XII. Fig. 5.) and thirty-two small rundlets that have the same numbers. On the tablets ques-
tions

tions are wrote, and four of the rundlets contain different answers to each question. A person puts the dial over any one of the tablets, and turning the hand round, it stops at the number which is marked on the rundlets that contain the answer.

RECREATION XLIII. p. 177

The incomprehensible card.

A very thin steel magnet is concealed in a card. You present a pack to a person that he may draw one, and offer the card with the magnet: he is then at liberty to conceal the card, or replace it, privately, in the pack, and you tell, by your perspective, whether it be there or not.

RECREATION XLIV. p. 178

The two magical cards.

At the bottom of a small box (Plate XII.

Fig. 6.) a pivot is placed, on which

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turns

turns a pasteboard circle that contains a touched needle, and on which two cards are painted; and in the top of the box is a hole, by which those cards are visible. You are to have a pack of cards that has a long and wide card, which are the same as those in the box: these two cards are to be drawn by two persons, and by applying your magnetic wand to the box, either of the cards becomes visible, at pleasure.

R E C R E A T I O N XLV. p. 180

The magnetic planetarium.

A round moveable pasteboard is placed at the bottom of a box, (Pl. XIII. Fig. 1.) at its center a circle is drawn, and seven other circles round that; and cross each of these a magnet is fixed. Over this pasteboard another is placed, on which are drawn eight corresponding circles; in that at the center seven questions are wrote, and in the others are words that
answer

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answer those questions, and on each of these circles turns a magnetic needle. The lower circle is moved by a hand fixed to its axis, which comes through the upper circle; and when the lower pasteboard is moved, the attraction of its magnets moves all the needles on the upper board. A person therefore setting the hand to any one of the questions in the central circle, the needles on the other circles immediately point to the words that compose the answer.

CONSTRUCTION OF THE MAGNETICAL AND MECHANICAL TABLE. p. 186.

Under the top of this table, (Plate XIV. Fig. 1.) and about one inch and a half from it, is another surface, on which is placed the magnetic apparatus, by which the subsequent recreations are performed. The legs of this table, Fig. 2, are hollow, and through them, and the step that joins to them,
goes

goes a cord, that comes out behind the partition, and passing over a pulley, plate XV, has a weight joined to the end of it, and to it is likewise fixed an index. On the upper surface of this table are placed, in succession, three circles, (Plate XIV. Fig. 1, 4, and 5.) on whose circumference are different numbers of divisions, that correspond to the divisions in the several columns of the table, Pl. XV. One of these circles is placed on that part of the table which is over the magnetic bar; on the circle is placed a shallow basin with water in which floats the figure of a firen, that contains a touched needle: therefore, when the person behind the partition places the index on the cord against any one division of the table, he will, by moving the magnetic bar under the circle, make the firen point to a letter or number in a corresponding division of that circle.

C O N T E N T S. 283

RECREATION XLVI. p. 194

To make the firen of the magnetic table point to all the letters of a given word.

On three cards that are each of a different size, are wrote the names of three persons or cities. These three cards being given to any person, he keeps one of them and returns you the other two, which you lay aside without looking at them, and the firen immediately points to the letters that compose the word on the card the person has taken. For you distinguish by the touch which of the three cards is chose, and by certain words, previously agreed on, make it known to the confederate.

The firen is to point out the time expressed by any given watch. p. 195.

A part of the step on which the operator stands, goes through the partition,
and

and is moveable, like a lever. The watch is laid on the table, and the operator presses down the step with his foot as many times as are equal to the number of hours which the confederate behind the partition observing, makes the firen point to that number. A similar signal is then made for the quarters and minutes.

To make the firen point to three numbers that have been chosen by three different persons, p. 196.

These three numbers are drawn from a bag, in which there are several divisions; and the confederate knowing what those numbers are, makes the firen point to them.

A ques-

A question being proposed, the siren gives the answer; though the person who exhibits the Recreation does not know the question,
p. 198.

On five cards are wrote five different questions, but which may be all answered by one word. A person chooses any one of these cards, and lays the rest aside: the confederate knowing the word that will answer it, makes the siren point to the several letters which compose that word.

RECREATION XLVII. p. 200

The sagacious swan.

On the top of an oblong box (Pl. XVI. Fig. 1.) is placed a shallow basin, in which floats the figure of a swan, that contains a touched needle. Round this basin are placed six small vases, and in each of them is put an answer to a question

tion. At the other end of the box is an ivory egg, on a hollow stand. There are six etwees, Fig. 3, of different lengths, and that each contain a question. A person having chose one of the etwees, takes out the question, and puts the etwee into the egg, and by shutting down the top of the egg presses the etwee down the hollow stand, and against a movement in the box, Fig. 2, by which mean a magnetic bar is brought under a particular part of the bason, according to the length of the etwee, and the swan is thereby directed to the vase that contains an answer to the question.

THE COMMUNICATIVE BELL. p. 205

In a hollow circular box, (Plate XVII. Fig. 1.) there is fixed a small bell, and at the center of the box is a pivot, on which is placed a touched needle, that has at each end a small brass knob. The bottom of this box is covered with gauze

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gauze. This box is placed on the magnetic table, over that part where there is a large magnetic bar, by moving of which the touched needle on the pivot is made to strike the bell.

RECREATION XLVIII. p. 207

To tell by the communicative bell, the card that a person has drawn from the pack.

The founding of the bell signifies *yes*, and its silence *no*.—You are to present the pack in such manner that the person will naturally draw the card you offer, and which is known to your confederate. You then ask several questions of the bell, which your confederate resolves, either by making it found or remain silent.

To tell, by the bell, at what number, from the top, any card of a pack is placed, that a person shall name, p. 208.

The cards of piquet being previously packed, they are to be shuffled in the

manner directed in the first volume, and they will then be in a determinate order; of which the confederate having a copy, and hearing the name of the card the person has chose, makes the bell strike the number at which it is from the top.

RECREATION XLIX. p. 211

The magnetic balance.

A pair of steel scales, that are gilt and very true. (Pl. XVII. Fig. 2.) are suspended over the magnetic table, near the part under which the bar is placed. Two pieces of money that are precisely of the same weight being put in these scales either of them is made to preponderate at pleasure. The confederate, at a signal given, bringing the bar under one or other of the scales.

RECRE-

C O N T E N T S. 289

RECREATION L. p. 214

The sympathetic dials.

One of these dials has a catch on the outside, by which it is stopped at pleasure: the other has a steel catch within the case, that takes the fly of the movement. A large bar in the magnetic table, when brought under this dial, attracts the catch and puts the wheels in motion, but when the bar is moved from it, the motion ceases immediately. You therefore give the dial with the stop to a person and tell him that when he stops that dial, or puts it in motion, the other on the table will, by sympathy, stop or move also; and by mounting the step, you make it act accordingly.

CONSTRUCTION OF THE MAGNETIC
ROLLER. p. 217.

This roller consists of a long and narrow piece of wood, (Pl. XVII. Fig. 5.) on which there are ten circles, and in each of them a magnet, placed in different

directions from the others. This roller. is placed at the bottom of the magnetic table, and moves upon two cylinders, being drawn by a string that goes down a leg of the table, through the partition, and over a pulley placed on the other side of it: to this string a weight and an index are fastened. Under the pulley is placed a table p. 220, that has five columns, which contain numbers, letters, the names of cards, countries, &c. and in each of these columns are ten divisions that correspond to the ten circles on the roller: so that when the index on the string is set by the confederate, against any one of those divisions, the circle on the roller that answers to it is brought to a certain part of the magnetic table, that the bar it contains may act on the needle of some machine to be placed over it.

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RECREATION LI. p. 221

The magician's box.

In a small hollow box (Pl. XVIII. Fig. 1.) is placed, on a pivot, a pasteboard circle, Fig. 3, which has ten equal divisions, in five of which cards are painted, and in the middle of it is a magnetic needle. In the top of the box is a hole, nearly of the same size with one of the divisions on the circle. Over this box is placed a glass cover, Fig. 2, and when it is put on the magnetic table, over the roller, any part of the circle may be made visible by bringing the proper circle of the roller under it. A similar experiment with a circle that has the names of five cities wrote on it, instead of the cards, p. 224.

RECREATION LII. p. 225

The mystical dial.

This dial has ten divisions, in which are wrote the nine digits and a cypher, and

U 2

it

it has a magnetic needle for an index, which points to any one of the ten divisions on the circle, according to the position of the magnet in the part of the roller over which it is placed. Method of showing by this dial the numbers that two persons have chose, their sum, or their product, p. 226.

RECREATION LIII. p. 228

The magical game of all-fours.

There must be a circle with twelve divisions, on six of which cards are painted and to which six of the divisions of the roller correspond. A pack of cards are previously disposed, according to the manner explained in the first volume; so that after the cards are dealt they can be played only one way. The other person plays his cards, yours remain on the table, and every time you are to play you direct another person to look in at the top of the box, (Pl. XVIII. Fig. 2.) and see what card is played, your

con-

confederate having brought the proper card in view, by moving the roller.

R E C R E A T I O N L I V . p. 231

The intelligent fly.

The space between two concentric circles contained in the box (Pl. XVIII. Fig. 5.) is divided into ten equal parts, in each of which a letter is wrote; and at the center of the circle, is placed a pivot, that holds a magnetic needle, at the end of which is the figure of a fly: all the needle, except that part to which the fly is fixed, is concealed by a paper placed over it. There are laid on a table a parcel of cards, properly packed, and on each of them a question is wrote. You ask a person at what number the card shall be to which the fly shall give him an answer. When he has determined, you place the box over the roller, and your confederate knowing the question on the card, makes the fly point to the letters that compose the answer.

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RECREATION LV. p. 236

The multifarious verse.

On eight tablets that are of the same size, and that exactly fill a box, (Plate XIX. Fig. 1.) are wrote the eight words of a Latin verse, and in each of them is placed a magnet in a different position. Over this box is placed a board, Fig. 2, that has eight circles, whose centers are directly over those of the tablets: round each of these circles are wrote the eight words of the Latin verse, and on each of them is placed a needle. Over the board and box is placed a glass frame, Fig. 3. If a person put the tablets in any position privately, then cover the box over with paper, and place it under the board, the needle on each circle will point to the word on the tablet under it; so that by looking into the top of the box you will always know in what order the tablets are placed.

R E C R E A T I O N LVI. p. 240

The communicative mirror.

In a box (Plate XX. Fig. 1.) is placed a pivot, on which is fixed a pasteboard circle, Fig. 2, that has a touched needle, and on which are painted three cards. Over this pasteboard is a hole, in the top of the box, and over that is placed a hollow glass pedestal, on which is fixed a tube, containing an inclined mirror. There are three tablets that have each a card, similar to those on the circle, and a magnetic bar. One of these being placed in the box, Fig. 3, and that put in the other box, Fig. 1, under the circle, it will place itself in a corresponding position: so that a person looking into the tube will see the same card as that on the tablet concealed in the box, and he will seem to see it in the mirror placed opposite the tube.

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RECREATION LVII. p. 243

The box of dice by reflection.

At each end of a long box (Pl. XX. Fig. 4.) is a small hole, and over the ends are placed two hollow cubes; under each of these cubes is an inclined mirror, and a small touched needle on a pivot. The top and two longest sides of this box are of glass, lined with a thin paper. There are two dice, that have concealed in each of their sides a small magnet: so that when these dice are placed in the cubes, in any position, you will see, by looking in at the hole at each end of the box, the position of the needle under each cube, and consequently discover which side of each die is next the top of the box.

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END OF THE THIRD VOLUME.

